A Work Project, presented as part of the requirements for the Award of a Master's degree in Economics from the Nova School of Business and Economics.

THE MACROECONOMIC EFFECT OF CORPORATE TAX CHANGES: DO CORPORATE TAX CHANGES AFFECT THE PORTUGUESE ECONOMY?

Fabio Nunziante Cesaro

Work project carried out under the supervision of:

Professor João B. Duarte

04-01-2021

The Macroeconomic Effect of Corporate Tax Changes: Do Corporate Tax Changes Affect The Portuguese Economy?

Fabio Nunziante Cesaro

Abstract

This paper investigates the impact of the marginal corporate tax rate changes on the Portuguese economy. We use a Structural Vector Autoregressive model for the analysis. The results indicate that an increase in the marginal corporate tax decreases the Portuguese output both in the long and short run. Our findings are significant and robust, besides the effect on the Eonia interest rate, which appears not significant.

Keywords: Marginal Corporate Tax, Effective Corporate Tax, SVAR, Unemployment.

Acknowledgements

I want to thank my supervisor, Professor João B. Duarte. Your lectures and feedback pushed me to sharpen my thinking and brought my work to a higher level. I want to thank Professor Giuseppe Russo. Your support and advice not only during my undergraduate studies have been fundamental in shaping my professional and personal profile. Then, I would like to thank my parents for their continuous support. You are always there for me. Finally, I could not complete this dissertation without the support of my friends, Matteo Matera, Tobias Tesing, and João Maria Cordeiro.

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

1 Introduction

In the OECD (2020) report, it is evident that OECD countries are lowering corporate and individual tax rates to boost investment, consumption, and labor market participation. The average corporate income tax rate across the OECD has dropped from 32.5% in 2000 to 23.9% in 2018. In fact, OECD countries with higher tax rates have been trying to push corporate tax rates toward the OECD average. This trend is evident in Figure 2. The graph shows the marginal corporate tax rate movement across countries. As we can notice, the corporate tax rate cut has been more evident before 2008, while after that period, corporate tax rates started to converge more slowly toward the overall average. The tax competition across countries is evident. In fact, in 2019, the OECD proposed to allow governments to tax operations in their jurisdiction even if companies have no physical presence there and set a global minimum corporate tax level. Through this mechanism, huge firms would have more difficulties in shifting profits and artificially decreasing the fiscal pressure. Given all these fiscal changes, it is important to understand the impact of those policies on economic growth. As we can notice from Figure 1, Portugal has been subjected to different fiscal reforms. In fact, the introduction of a progressive tax (Derrama Estadual) in 2010 and the changes applied to the federal and municipal tax over time offer an exciting scenario to study the impact of those fiscal reforms on the Portuguese economy. To do that, we collect data on corporate taxes in Portugal. More specifically, we gather the Portuguese effective corporate tax rate from 2005 to 2018 and the Portuguese marginal corporate tax rate from 2000 to 2020. We apply a Structural Vector Auto-regressive model (SVAR) on corporate taxes and the Portuguese CPI, GDP growth, and Eonia interest rate to understand the fiscal reforms' impact on the Portuguese economy. Moreover, we explore the effect of those corporate tax changes on the unemployment level. Then, we compute the impulse response functions, variance decomposition, and historical decomposition on the SVAR models. Our findings suggest that effective and marginal corporate tax rates are negatively correlated with Portuguese economic activity. A positive marginal corporate tax shock seems to be the strongest scenario when analyzing the Portuguese economy's long-term impact compared to the other cases. However, in the short-term, while the marginal corporate tax rate applied to the small - medium-sized and large firms seem to have the same effects on the economy, the effective tax rate has a higher

impact on the output growth. This work aims to assess the impact of corporate tax changes on the Portuguese economy, given the number of tax reforms in the country. The results confirm that economic growth is slowed down when corporate taxes are increased. Decreasing corporate taxes to stimulate output growth is also proposed in the paper by Macek, Rudolf (2015). The economic literature addressed many times the question:" How do changes in corporate taxation affect the economy?". In the paper by Hodge, S. A. (2017), the author finds a definite negative correlation between corporate income tax rate and economic growth. The study confirms that a corporate tax cut would stimulate investment and capital, and workers would benefit from this policy. Moreover, the paper by Johansson, Åsa, et al. (2008) demonstrates that corporate taxes are the most harmful for economic growth, followed by personal income taxes and then consumption taxes.

1.1 Why Corporate Tax?

The last question we want to address before diving into the empirical strategy is:" Why the impact of a change of the corporate tax rate? Why, among all the types of taxes, we choose the corporate one?". The corporate income tax is one of the variables that most influence economic growth, and thus the possibility to change it gives governments a powerful fiscal policy tool. The first reason that explains why the economic activity is so sensitive to corporate income tax changes is connected to the high mobility of the capital. As described in the paper by Devereux, Michael P., and Rachel Griffith (2002), there is some evidence that taxes affect firms' location and investment decisions. In fact, while for a worker, it is challenging to change a country or city to get a new job and hope for a higher wage, for a firm is relatively more painless, locates its next investment in a lower-tax jurisdiction. Second, as capital moves away in response to high statutory corporate income tax rates, productivity, and wages for the relatively immobile workers fall. Empirical studies show that labor bears part of the burden of the corporate income tax. For instance, in the paper by Felix, R. Alison (2007), the author demonstrates that a 10% point increase in the corporate tax rate of high-income countries reduces mean annual gross wages by 7%. Our findings suggest that a positive marginal corporate tax shock increases the unemployment rate by roughly 2 point percentage in the medium-term, confirming the negative

impact of the corporate tax increase on the labor market.

2 Methodology

We use the structural vector autoregression (SVAR) exposed by Zivot, Eric (2000) to describe the joint dynamics of the Portuguese marginal tax rate T_t, Portuguese GDP growth g_t, Portuguese inflation rate π_t and Eonia interest rate i_t. Let be $y_t = (T_t, g_t, \pi_t, i_t)$ be the 4x1 vector of observables. The SVAR takes the form:

$$Ay_t = B_0 + B(L)y_{t-1} + \epsilon_t$$

$$\begin{bmatrix} 1 & b_{1,2} & b_{1,3} & b_{1,4} \\ b_{2,1} & 1 & b_{2,3} & b_{2,4} \\ b_{3,1} & b_{3,2} & 1 & b_{3,4} \\ b_{4,1} & b_{4,2} & b_{4,3} & 1 \end{bmatrix} \begin{bmatrix} y_{1,t} \\ y_{2,t} \\ y_{3,t} \\ y_{4,t} \end{bmatrix} = \begin{bmatrix} \gamma_{1,0} \\ \gamma_{2,0} \\ \gamma_{3,0} \\ \gamma_{4,0} \end{bmatrix} + \begin{bmatrix} \gamma_{1,1} & \gamma_{1,2} & \gamma_{1,3} & \gamma_{1,4} \\ \gamma_{2,1} & \gamma_{2,2} & \gamma_{2,3} & \gamma_{2,4} \\ \gamma_{3,1} & \gamma_{3,2} & \gamma_{3,3} & \gamma_{3,4} \\ \gamma_{4,1} & \gamma_{4,2} & \gamma_{4,3} & \gamma_{4,4} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \\ y_{3,t-1} \\ y_{4,t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \\ \epsilon_{3,t} \\ \epsilon_{4,t} \end{bmatrix}$$

$$D = \begin{bmatrix} \sigma_1^2 & 0 & 0 & 0 \\ 0 & \sigma_2^2 & 0 & 0 \\ 0 & 0 & \sigma_3^2 & 0 \\ 0 & 0 & 0 & \sigma_4^2 \end{bmatrix}$$

where:

A: 4x4 matrix describing the contemporaneous relations in the model.

B_0: 4x1 vector of constants.

$B(L)$: 4x4 matrix associated with each lag of y_t.

ϵ_t: 4x1 vector of structural shocks assumed to be , $N(0, D)$ and mutually uncorrelated.

The reduced-form vector autoregression associated with the SVAR model above mentioned is given by:

$$y_t = \Phi_0 + \Phi(L)y_{t-1} + u_t$$

where:

$Phi_0 = A^{-1}B_0$.

$Phi_1 = A^{-1}B(L)$.

$u_t = A^{-1}\epsilon_t$.

$\mathbf{E}[u_t(u_t)'] = \Omega = A^{-1}D(A^{-1})'$.

However, without some restrictions, the parameters in the SVAR model are not identified. In our case we assume that $b_{1,2} = b_{1,3} = b_{1,4} = b_{2,3} = b_{2,4} = b_{3,4} = 0$. To demonstrate the robustness of our results we show that even after changing these restrictions, the results do not change, meaning that our findings do not depend on the underlying assumptions.

3 Data and Empirical Strategy

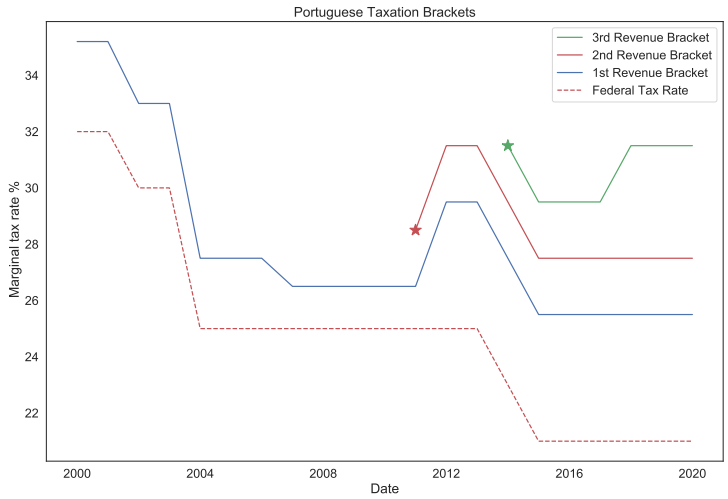
The dataset is entirely acquired from the Federal Reserve, the European Central Bank, the OECD website, and the official reports of Portugal's Autoridade Tributiaria. The dataset comprises the Portuguese Consumer Price Index (CPI), Portuguese Government Domestic Product (GDP), Eonia tax rate, Portuguese marginal corporate income tax rate, the Portuguese effective corporate income tax rate, and the Portuguese unemployment rate. Moreover, the data frame measure is available beginning in 2000 and ending in 2020. In quarterly terms, our data frames are composed of 81 observations. The data frame incorporating the effective tax rate has 53 observations beginning in 2005 and ending in 2018. Since the Eonia tax rate frequency is daily, that one of the CPI, GDP, Unemployment is quarterly, and the marginal and effective tax rates' one is yearly, we first harmonize them through linear interpolation, getting the whole dataset in quarterly terms. Once the dataset is ready to be used, we create four different data frames. The first one comprises the marginal corporate income tax rate, GDP, CPI, and Eonia interest rate. The second one comprises the effective corporate income tax rate, GDP, CPI, and the Eonia tax rate. The third one comprises the highest marginal corporate income tax rate, GDP, CPI, and Eonia tax rate. The fourth comprises the marginal corporate tax rate, GDP, Unemployment, CPI, and Eonia interest rate. All variables enter their logarithm, except for the Eonia interest rate, the marginal, effective tax rate, and the unemployment rate. By multiplying the logarithm

of GDP to 100, we obtain their growth rates in percentage terms. By Specify the variables in this particular order in the Var model, we imply some restrictions. Organizing the variables in this way allows us to not allow for the GDP growth's contemporaneous effect on the tax rate. We do not allow for a contemporaneous effect of unemployment on the GDP and the tax rate. We do not allow for a contemporaneous effect of the inflation rate on the GDP growth, unemployment, and the marginal tax rate. Finally, we do not allow for a contemporaneous effect of the eonia tax rate on inflation, GDP growth, unemployment, and marginal tax rate. The restrictions are based on the assumption that the tax variables are the most exogenous ones, while the eonia interest rate is the most endogenous one. The variables are not used in differences to use long-run information, as demonstrated by Sims, C. A., Stock, J. H., Watson, M. W. (1990). This approach is valid since the analysis is not concerned with hypothesis testing but with structural analysis of the variables' relationship.

4 Taxation Scheme in Portugal

To take a closer look at the Portuguese taxation scheme, let us analyze how the marginal corporate income tax rate has changed over time. On top of the marginal corporate income tax rate mentioned above, firms have to pay two additional taxes: the "Derrama municipal" and the "Derrama Estadual." The first one is fixed and connected to the "Municipio," where the firm is located, and the second one is progressive and connected with the firm's profit. Portugal is the only country to have a progressive surtax among the countries considered in this work. The Derrama Municipal tax is an old tax and before 2007 had a ceiling of 10%. Then, after 2007, the government imposed a maximum of 1.5%. In fact, the Derrama Municipal was 3.2% in 2000, and it decreased to 1.5% in 2007. We should point out that the Portuguese taxation scheme has been changing a lot over time. In fact, the federal marginal tax rate changed, and the two surtaxes and the revenue brackets subjected to the Derrama Estadual have been the center of different reforms. Regarding the Derrama Estadual, it was introduced in 2010 and went into effect in 2011. This tax is progressive, and thus, based on the firms' revenue. In the beginning, this tax had just two revenue brackets, and then, as can be seen in the figure below, in 2014, a

Figure 1: Portuguese taxation brackets and federal tax



third bracket was introduced. To add this tax to the average marginal Portuguese tax rate, we compute a weighted average based on the amount of taxes paid by the firms falling in a certain revenue bracket compared to the total amount of taxes collected. In the 2016/18 official report of the Autoridade Tributaria, is stated that firms producing 500.000 euros – 2.5 million contribute to the 24% of the taxes collected, firms producing 2.5 million – 25 million contribute to the 21.7% of the taxes collected, firms producing more than 25 million contribute to the 54,3% of the taxes collected. As expected, even though the largest firms are fewer than the small and medium ones, they contribute more to government revenue. Looking at figure 1, we can understand how much the Portuguese taxation scheme has changed over time. Moreover, we can notice the important difference between the marginal tax firms falling in the first and last revenue bracket pay (6%) in 2020. Then, we can notice that the federal and marginal tax rates in 2000 have been moving together, while from 2011 after introducing the Derrama Estadual, the difference between the federal and marginal tax rates has been widening, complicating the Portuguese taxation framework. The progressive nature of the Derrama Estadual and the large variance between the different marginal tax rates in Portugal justifies our curiosity on exploring how a change in the last bracket of taxation would affect the Portuguese economy.

Let us now examine how the Portuguese level of taxation ranks among different countries. To adequately understand the Portuguese taxation framework and whether the Portuguese tax level is high compared to other countries' one, let us look at figure 2. We immediately see that Portugal ranked second, between Germany and Italy, while Ireland is the country with the lowest

Figure 2: Marginal corporate tax rate across countries

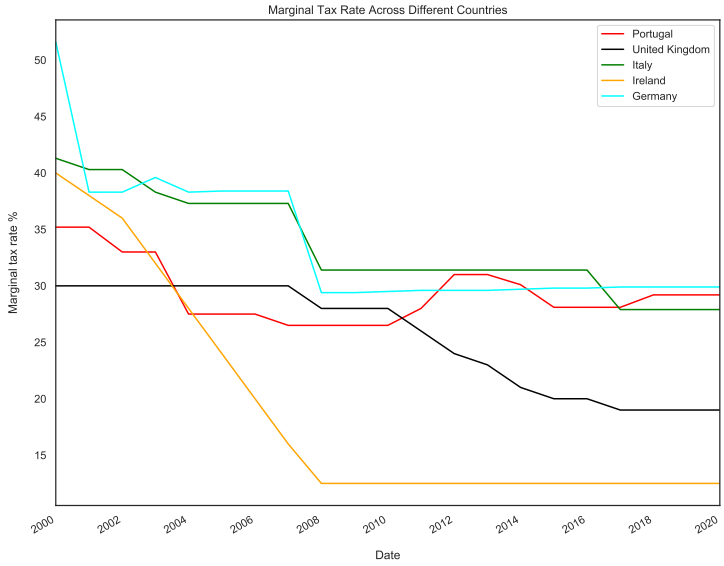
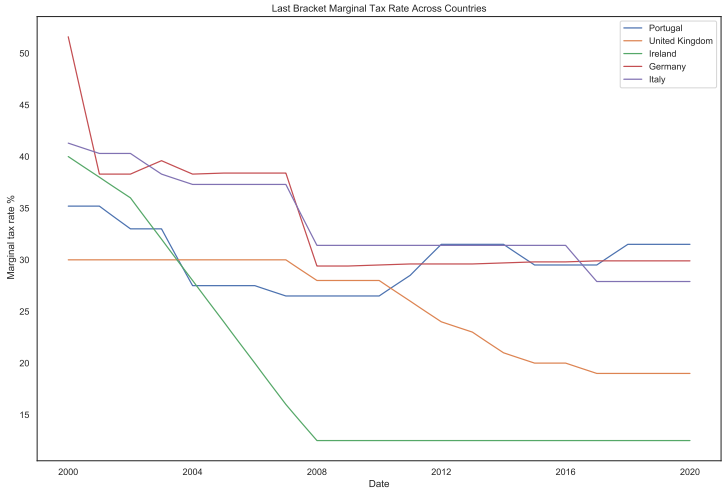


Figure 3: Last bracket marginal tax rate across countries



marginal tax rate. It also clarifies the general trend European countries undertook in terms of marginal tax rate level. We can see that taxes have been lowering over time. This condition implies that lowering taxes in the past had more impact than doing it now. The reason is that investments need lower taxes nowadays to be channeled, and since the world debt is increasing and taxes are lowering, the fiscal policy maneuver of countries is shrinking. Above, we mentioned the peculiarity of the Portuguese taxation scheme compared to that one of the other countries considered. The introduction of the Derrama Estadual changes the ranking when comparing the marginal tax firms falling in the last revenue bracket have to pay. Looking at figure 3, we see Portugal ranking first, meaning that firms that contribute more to GDP and government

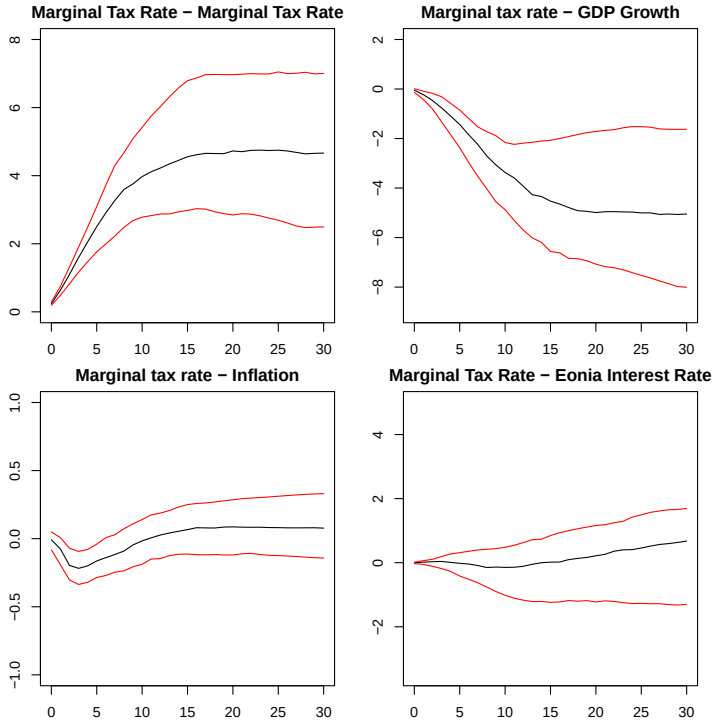
revenue pay more taxes in Portugal than in Germany.

5 Impact of the Average Marginal Corporate Tax

The next step is running a Vector Autoregressive model to understand the impact of an average and last bracket marginal tax and effective tax change on the Portuguese GDP growth, inflation level, eonia interest rate, and unemployment rate. This analysis provides the policymaker a useful tool for understanding the short and long-term impact of a change in Portugal's corporate taxes. We first apply a Vector Autoregressive model to the first dataset constituted of the Portuguese average marginal corporate tax rate, Portuguese GDP growth, Portuguese Inflation rate, and Eonia interest rate. We placed the variables in this specific order for simulating a permanent and sudden change of the marginal tax rate triggered by the Portuguese government. As mentioned above, specifying this particular order in the SVAR model implies some restrictions: 1.We do not allow for the contemporaneous effect of the GDP growth on the marginal tax rate. 2.We do not allow for a contemporaneous effect of the inflation rate on the GDP growth and the marginal tax rate. 3.We do not allow for a contemporaneous effect of the Eonia tax rate on inflation, GDP growth, and marginal tax rate. We decide to follow the HQ information criterion. However, even though two lags are indicated, the Var residuals are not stationary. Thus we choose three lags. We must state that the other information criteria suggest the use of two lags. Moreover, the roots of the characteristic equation are all stable. After having run the Var, we check for the stationarity of the residuals. This condition is essential to ensure a not spurious regression and thus have reliable results. The Var residuals appear all stationary at a 5% level of confidence. Then, we compute the Impulse Response functions representing an orthogonal response of all the variables to a permanent shock of the average marginal corporate tax rate triggered by the government. Since we are operating with time series, we use a confidence interval of 0.68 to compute the impulse response function bands. Moreover, we want to simulate a permanent tax increase; thus, cumulated impulse response coefficients are computed.

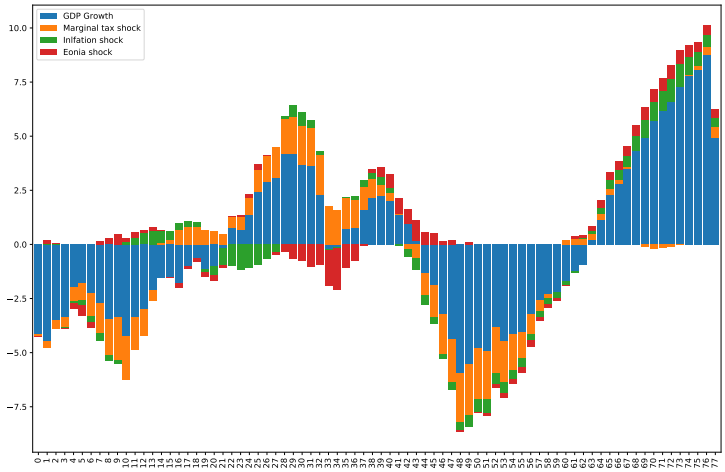
Looking at the Impulse response functions, we notice in figure 4 that in the short-term (five quarters), one standard deviation increase of the marginal tax rate (0.24 percentage point) de-

Figure 4: Average marginal tax rate impulse response functions



creases GDP growth by -1.1 percentage point. This result suggests a strong response of the GDP growth to average marginal tax changes. Moreover, GDP growth declines by -4.94 percentage points after five years. The cumulative Impulse response functions show a marginal corporate tax/GDP growth ratio equal to -2 in the short-term and equal to -1 in the long-run. By contrast, the inflation rate declines slightly only in the short - run. In particular, the inflation rate response appears statistically significant only in the third, fourth, and fifth quarter. Inflation's negative response peak is recorded in the fourth quarter and is equal to -0.21 percentage points. The inflation rate reaction is perfectly in line with the economic theory. The increase in the taxation level acts as a push factor that decreases the aggregate demand and the general price level. In other words, while a corporate tax cut increases inflation boosting the economy in the short run, increasing corporate tax does precisely the opposite. The Eonia interest rate appears not statistically different from zero both in the short and long - run. This finding confirms that the GDP growth decline does not depend on business cycles but is a direct effect of an exogenous increase in taxation. If the GDP drop had followed the business cycle, the European Central Bank would have reacted by lowering the Eonia interest rate. In summary, these impulse response functions reflect an application of higher taxation on firms' profit, which leads to less

Figure 5: Historical Decomposition of the Portuguese GDP Growth

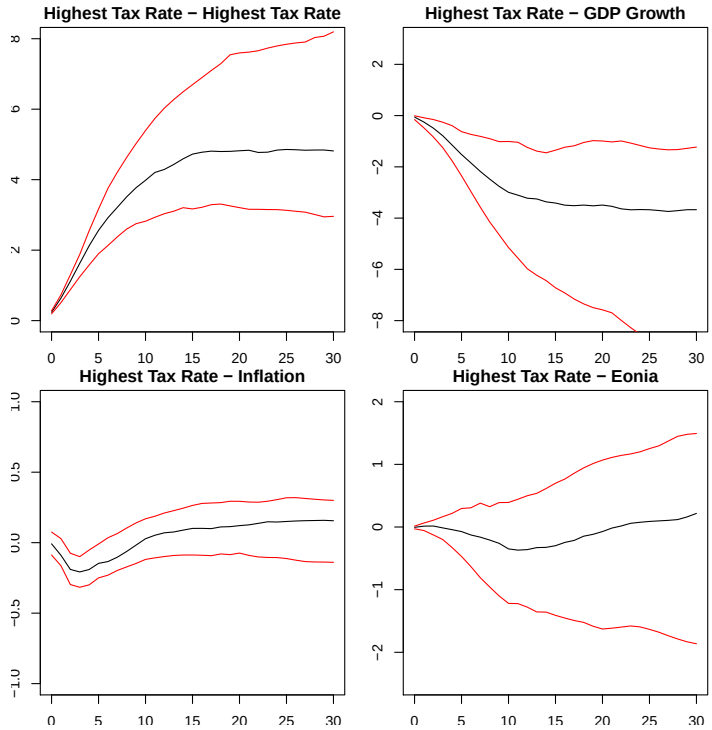


investment capacity of the latter, and thus a contraction of the demand side of the economy, decreasing GDP in the short and long - run, and inflation in short - run. A confirmation of the substantial relation between the average marginal tax rate and GDP growth can be found in the Variance Decomposition. The Variance Decomposition tells us how much of the dependent variable's variability is attributable to its lags. Besides, it shows which of the independent variables is more important in explaining the dependent variables' variability over time. We see that after ten quarters, GDP growth variability is explained by the marginal tax rate for 17%, by the inflation component for 5%, by the Eonia component for 2%, and what remains is explained by the GDP growth's lags. Moreover, we can see how inflation variability is independent of the other variables. In particular, the inflation variability is for the 96% explained by its lags, while the marginal tax rate component explains just the 4%. Then, we notice that in the 10th quarter, the Eonia interest rate variability is explained by 12% of the GDP and by 2% of the inflation rate and marginal tax rate while what remains is mainly explained by Eonia's lags. Figure 5 shows the Historical Decomposition of GDP growth from 2000 to 2020. The historical decomposition is useful to understand what portion of the deviation of the endogenous variables from their unconditional mean is due to each shock. In our case, we want to show which variables explain most of the GDP growth deviation from its unconditional mean. Figure 5 shows that output growth fluctuations are mainly explained by the marginal corporate tax shock.

6 Impact of the Highest Marginal Corporate Tax

As mentioned in the ”taxation scheme in Portugal” paragraph, the Portuguese taxation scheme is not only composed of flat taxes. It also incorporates a progressive component that was introduced in 2010, the Derrama Estadual. As shown above, this tax creates an important difference between how much firms falling in the first and last bracket pay. This situation, together with the fact that firms in the last tax bracket contribute more to the Portuguese government revenue, motivates us to analyze the consequences of a marginal tax rate change imposed on the largest firms. For this analysis, We decide to follow the Akaike information criterion. However, even though the other information criteria indicate two lags, the residuals are not stationary. Thus three lags are chosen. We must state that the other information criteria suggest the use of 2 lags. Moreover, the roots of the characteristic equation are all stable. After having run the Var, we check that the Var residuals are stationary. This condition is essential to ensure that we do not obtain a spurious regression and have reliable results. The residuals appear all stationary at a 5% level of confidence. Then, we compute the Impulse Response functions representing an orthogonal response of all the variables to a permanent shock of the highest marginal corporate tax rate triggered by the Portuguese government. Since we are operating with time series, we use a confidence interval of 0.68 to compute the impulse response functions. Moreover, we want to simulate a permanent tax increase; thus, cumulated impulse response coefficients are computed. Looking at the Impulse Response functions, we can notice that the impact of the highest marginal tax rate change on the Portuguese economy is in line with what we observed in the previous Impulse response functions. Looking at the Impulse response functions, we can notice that in the short-term (five quarters), one standard deviation increase of the marginal tax rate applied to the largest firms (0.23 percentage points) declines GDP growth by -1.1 percentage points. This finding suggests a strong response of the GDP growth to marginal tax changes. Moreover, GDP growth drops by -4.04 percentage points after five years. However, we observe that the impact of the marginal tax rate on the GDP growth is weaker than in the previous case in the long-term. While in the previous case, the tax/GDP growth ratio was equal to -1 percentage points, in this case is -1.2 percentage points. By contrast, the short-term impact of the two taxes seems to be the same. This result suggests that since the largest firms are less responsible for job

Figure 6: Highest marginal corporate tax rate impulse response functions

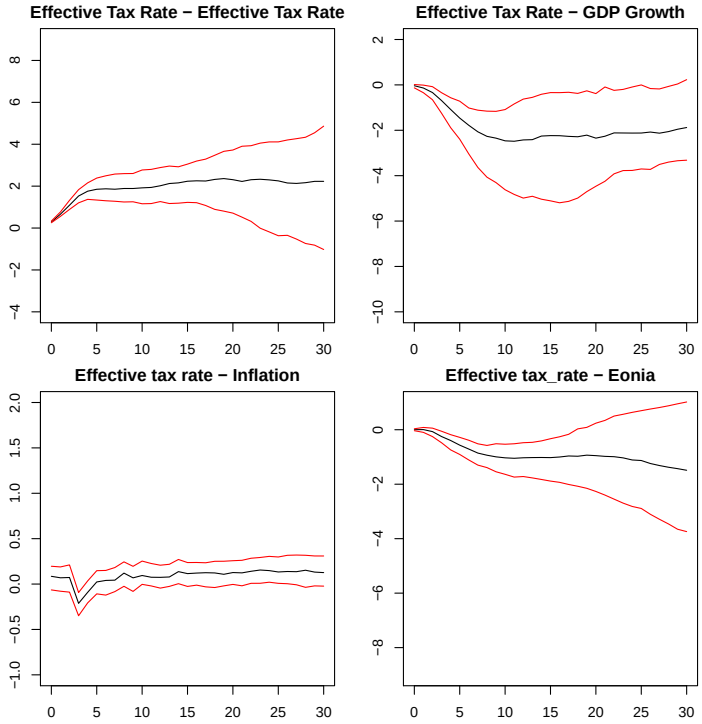


creation, the overall consumption effect is smaller than that one we would have obtained by increasing the average marginal corporate tax. The inflation rate is only statistically significant in the short-run and negatively correlated to the highest marginal corporate tax rate. The inflation rate is statistically significant in the third, fourth, and fifth quarter, with a negative peak of -0.16 percentage points in the third quarter. The Eonia interest rate is not statistically significant both in the short and long - run. Once again, it confirms that the GDP growth decline does not depend on business cycles but is a direct and indirect effect of an increase in taxation. By observing the variance decomposition, we notice that the marginal tax rate is a stronger component in explaining the GDP growth variability than in this situation. While in the previous SVAR model, the variance decomposition shows that GDP growth is caused by the marginal tax rate for 17%, in this case, the last bracket marginal tax rate accounts for 12%. This finding suggests that the marginal tax rate explains the GDP variability more than the marginal tax rate applied to the largest firms. In other words, even though the marginal tax rate used in this model is applied to firms responsible for the 54.3% of the taxes collected in Portugal, our findings suggest that the Portuguese GDP growth is more sensitive to a shock of the average marginal corporate tax rate.

7 Impact of the Effective Corporate Tax

In the first paragraph, we compare the Portuguese marginal tax rate with that of other countries. We see that the Portuguese average marginal tax rate ranks second, while the Portuguese highest marginal tax rate is the highest among the countries taken into consideration. However, in order to measure the competitiveness of a country in terms of the corporate tax rate, we have to compare the effective tax rate. The effective tax rate is the effective part of profit corporates pay, and it is lower than the marginal tax rate when computed. The effective tax rate is entirely acquired from the official reports of the Portuguese Autoridade Tributaria. The dataset, unfortunately, is smaller than the previous ones. The importance of the effective tax rate in measuring a country's tax competitiveness motivates us to analyze the consequences of an effective tax rate change on the Portuguese economy. We decide to follow the Akaike information criterion. However, even though ten lags are indicated, in order to be parsimonious, five lags are chosen. We must state that the other information criteria suggest the use of 10 lags. Moreover, the roots of the characteristic equation are all stable. After having run the Var, we check that the Var residuals are stationary. The residuals appear all stationary at a 5% level of confidence. Then, we compute the Impulse Response functions that represent an orthogonal response of all the variables to a permanent shock of the effective tax rate triggered by the government. Since we are operating with time series, we use a confidence interval of 0.68 to compute the impulse response functions. Moreover, we want to simulate a permanent tax increase; thus, cumulated impulse response coefficients are computed. Looking at the Impulse response functions, we can notice that in the short-term (five quarters), one standard deviation increase of the effective tax rate (0.29 percentage points) declines GDP growth by -1.1 percentage points, suggesting a strong response of the GDP growth to effective corporate tax changes. Moreover, GDP growth declines by -2.21 percentage points after five years. The results demonstrate an effective corporate tax/GDP growth ratio of 1 percentage point in the long-run and -1.6 percentage points in the short-run. This finding suggests that the Portuguese GDP growth is more sensitive to a shock of the effective tax rate than the average marginal or highest marginal tax rate in the short-term. The inflation rate reacts with the same power as before and slightly contracting in the short-term. In this case, the inflation rate appears statistically significant only in the fourth quarter.

Figure 7: Effective tax rate impulse response function



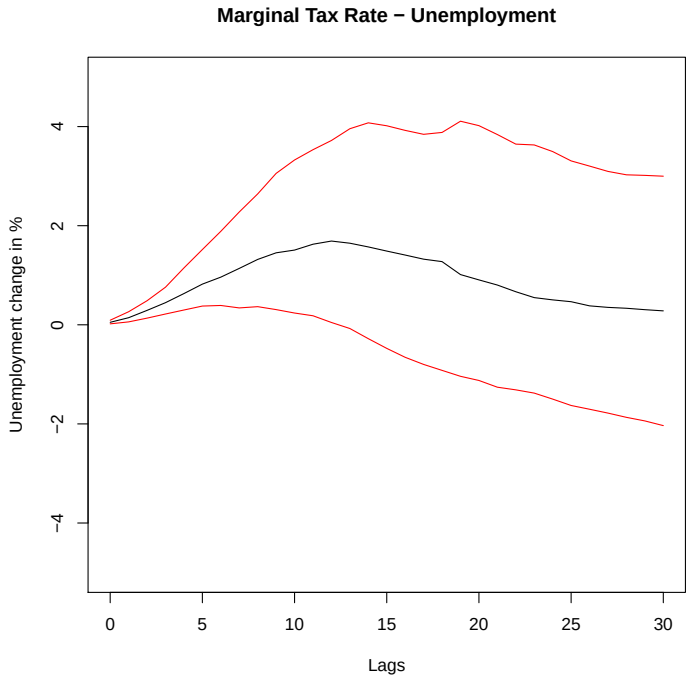
By contrast, the Eonia interest rate appears statistically different from zero from the fourth to the sixteenth quarter, suggesting a negative correlation between the effective corporate tax rate and the Eonia interest rate in the short and medium-term. In this case, the European Central Bank seems to react to the Portuguese GDP decline. Analyzing the variance decomposition, we can notice that GDP growth variability is explained by the effective tax rate component for 17%, by its lags for 42%, by inflation for 38%, and by Eonia interest rate for 3%. The inflation rate variability is explained in the short - run by the Effective tax rate change for 17%, by the GDP and Eonia interest rate for 3%, and what remains is explained by its own lag's. The Eonia variability is explained by the effective tax rate component for 45%, by its lags for 40%, inflation for 11%, and by GDP for 4%.

8 Impact of the Average Marginal Corporate Tax on Unemployment

In the section "Why corporate tax?" we state that a portion of the economic downturn generated by an increase in corporate tax is beared by workers. More specifically, increasing corporate tax would eventually increase unemployment and decrease real wages. To demonstrate that corporate tax increase positively impacts the unemployment growth, we run an unrestricted Var. The dataset comprises the average marginal tax rate, GDP growth, unemployment growth, inflation rate, and Eonia interest rate. We decide to follow the HQ information criterion, and two lags are chosen. Moreover, the roots of the characteristic equation are all stable. After having run the Var, we check that the Var residuals are stationary. The residuals appear all stationary at a 5% level of confidence. Then, we compute the Impulse Response functions representing an orthogonal response of all the variables to a permanent shock of the average marginal tax rate triggered by the government. Since we are operating with time series, we use a confidence interval of 0.68 to compute the impulse response functions. Moreover, we want to simulate a permanent tax increase; thus, cumulated impulse response coefficients are computed.

Looking at figure 8, we notice that unemployment reacts positively to a one standard deviation increase of the average marginal corporate tax (0.23 percentage points). The effect is statistically significant from the first to the fifteenth quarter, reaching a peak of 1.95 percentage points in the thirteenth quarter. This finding is in line with the study of Zirgulis, Aras, and Tadas Šarapovas (2017). To explore how much of the GDP variability is explained by the unemployment component, we look at the variance decomposition. We observe that the unemployment component explains the GDP variability for the 22% in the long-run and the 10% in the short-run. This finding suggests that unemployment is a crucial component to explain the GDP drop triggered by a marginal corporate tax increase and that a marginal corporate tax increase is beared by workers both in the short and medium-term.

Figure 8: Marginal tax rate - Unemployment



9 Robustness: Vector Autoregressive model

The identification scheme we use in this work is the Cholesky identification. This procedure requires A to be a lower triangular matrix, placing zeros on all entries above the diagonal. In other words, this is the mathematical explanation of the contemporaneous effect restrictions explained in the section above. Shocks to an equation contemporaneously impact the variables below that equation. Bearing this in mind, we understand that the identification procedure we use reflects the assumptions about the underlying structure we decide to model. Placing the tax rate first, followed by GDP growth, inflation, and Eonia interest rate, we assume that tax is the most exogenous one, while the Eonia interest rate is the most endogenous one. With the Cholesky identification procedure, the order in which variables are placed matters. Changing the order of the variables in the Var model changes the impulse response functions. To check the robustness of our results, we change the order of our variables, and we compare the impulse response functions generated from these new identification procedures with those obtained in our Var model. More specifically, we simulate an exogenous shock of the GDP growth, inflation rate, and Eonia interest rate. The impulse response functions generated do not vary significantly from those obtained with our initial identification procedure, suggesting that the results are

robust.

10 Conclusion

This work investigates the impact of corporate tax changes on the Portuguese economy. We found that the average and effective corporate tax rate has a tax/GDP growth ratio equal to -1 in the long-run. The marginal corporate tax rate applied to the largest firms has a tax/GDP growth ratio equal to -1.2 in the long-run. This finding demonstrates that since the small and medium-sized firms are more responsible for job creation, a positive average marginal tax shock seems to be the strongest scenario when analyzing the long-term impact on the Portuguese economy. However, in the short-term, while the marginal corporate tax rates seem to have the same effect on the economy, the effective tax rate has a higher impact on output growth. In fact, the tax/GDP growth ratio is equal to -1.6 percentage points. This finding demonstrates that the Portuguese GDP growth is more sensitive to an effective corporate tax shock in the short-term compared to the other scenarios. Even though the results indicate a negative correlation between corporate taxation and economic growth, as demonstrated in the work by Engen, Eric M. (1996), the effect we find seems too large. In the paper by Johansson, Åsa, et al. (2008), the authors demonstrate once again the negative correlation between corporate taxes and economic growth. However, they found that a 5% corporate tax rate shock would eventually decrease output growth by 0.4% after ten years. When we look at the Portuguese unemployment rate's role, we understand that a positive average marginal corporate tax shock increases unemployment by roughly 2 percentage points in the medium term. Even though the results are in line with the study of Zirgulis, Aras, and Tadas˘ Sarapovas (2017), the effect is higher than expected. The unemployment rate seems to explain 20% of the GDP growth variability, demonstrating that a discrete part of the corporate tax increase is beared by workers. The inflation rate is impacted negatively by an increase in the marginal corporate taxation in the short-term, while it is not statistically significant in the long-term. By contrast, the eonia interest rate is not statistically significant, demonstrating the independence of our model from business cycles. Only when analyzing the impact of the effective corporate tax rate, the Eonia interest rate declines by -1.20 percentage points in the

medium-term.

These findings demonstrate the impact of corporate tax changes on the Portuguese economy and the importance of fiscal policies in shaping the economy.

11 References

Devereux, Michael P., and Rachel Griffith. "The impact of corporate taxation on the location of capital: a review." Swedish Economic Policy Review 9.1 (2002): 79-106.

Engen, Eric M., and Jonathan Skinner. Taxation and economic growth. No. w5826. National Bureau of Economic Research, 1996.

Felix, R. Alison. Passing the burden: Corporate tax incidence in open economies. No. 468. LIS Working Paper Series, 2007.

Hodge, Scott A. "The Economic Effects of Adopting the Corporate Tax Rates of the OECD, the UK, and Canada." Tax Foundation, Fiscal Fact 477 (2017).

Kilian, Lutz, and Helmut Lütkepohl. Structural vector autoregressive analysis. Cambridge University Press, 2017.

Macek, Rudolf. "The impact of taxation on economic growth: case study of OECD countries." Review of economic perspectives 14.4 (2015): 309-328.

OECD (2020), Tax Policy Reforms 2020: OECD and Selected Partner Economies, OECD Publishing, Paris, https://doi.org/10.1787/7af51916-en. Export options: EndNote, Zotero, BibTeX, RefWorks, Procite, Import into RefWorks, Mendeley

Romer, Christina D., and David H. Romer. "The macroeconomic effects of tax changes:

estimates based on a new measure of fiscal shocks." American Economic Review 100.3 (2010): 763-801.

Sims, Christopher A., James H. Stock, and Mark W. Watson. "Inference in linear time series models with some unit roots." Econometrica: Journal of the Econometric Society (1990): 113-144.

Zirgulis, Aras, and Tadas Šarapovas. "Impact of corporate taxation on unemployment." Journal of Business Economics and Management 18.3 (2017): 412-426.

Zivot, Eric. "Notes on Structural VAR Modeling." Notas de clase disponibles en http://faculty. washington. edu/ezivot/econ584/584notes. htm (2000).

12 Appendix

Figure 9: Augmented Dickey Fuller test: Var Residuals average marginal corporate tax

Var Residuals Portuguese Average Marginal Tax Rate

Augmented Dickey-Fuller Test

data: (residuals(var2)[, 1])
Dickey-Fuller = -4.4537, Lag order = 4, p-value = 0.01
alternative hypothesis: stationary

Augmented Dickey-Fuller Test

data: (residuals(var2)[, 2])
Dickey-Fuller = -3.9248, Lag order = 4, p-value = 0.01757
alternative hypothesis: stationary

Augmented Dickey-Fuller Test

data: (residuals(var2)[, 3])
Dickey-Fuller = -4.4343, Lag order = 4, p-value = 0.01
alternative hypothesis: stationary

Augmented Dickey-Fuller Test

data: (residuals(var2)[, 4])
Dickey-Fuller = -3.5835, Lag order = 4, p-value = 0.04044
alternative hypothesis: stationary

Figure 10: PACF: Var residuals average marginal corporate tax

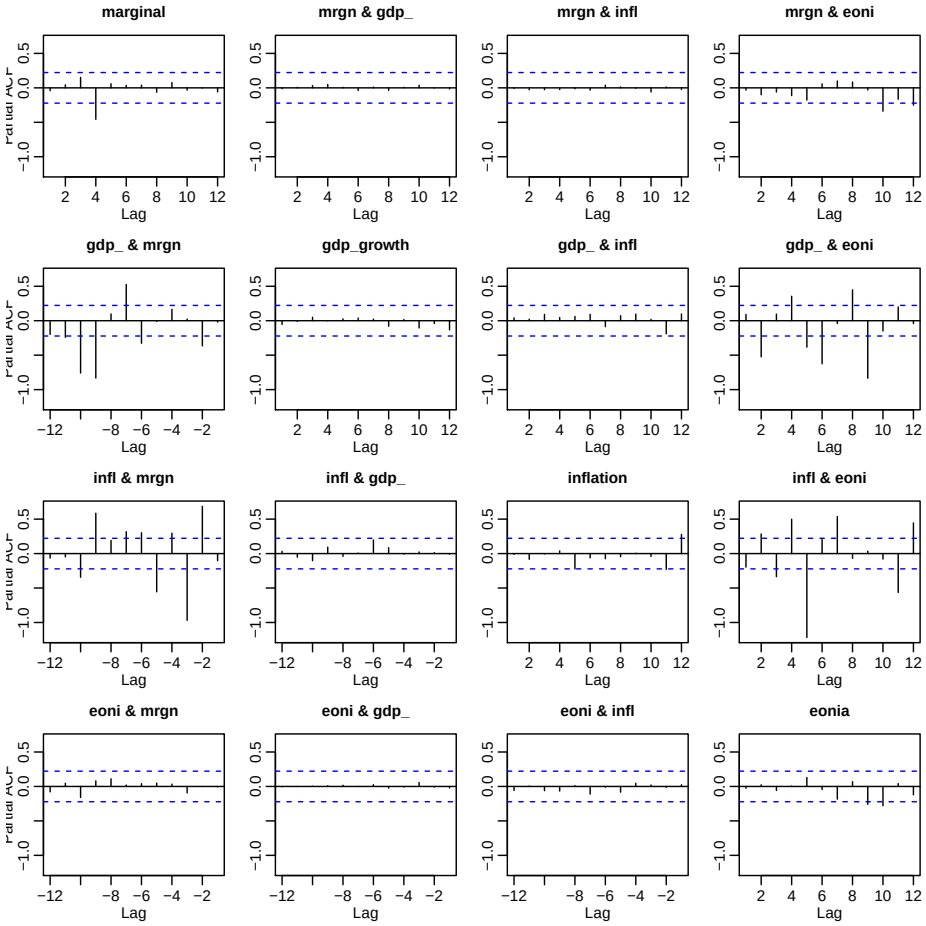


Figure 11: Variance Decomposition: Average marginal corporate tax

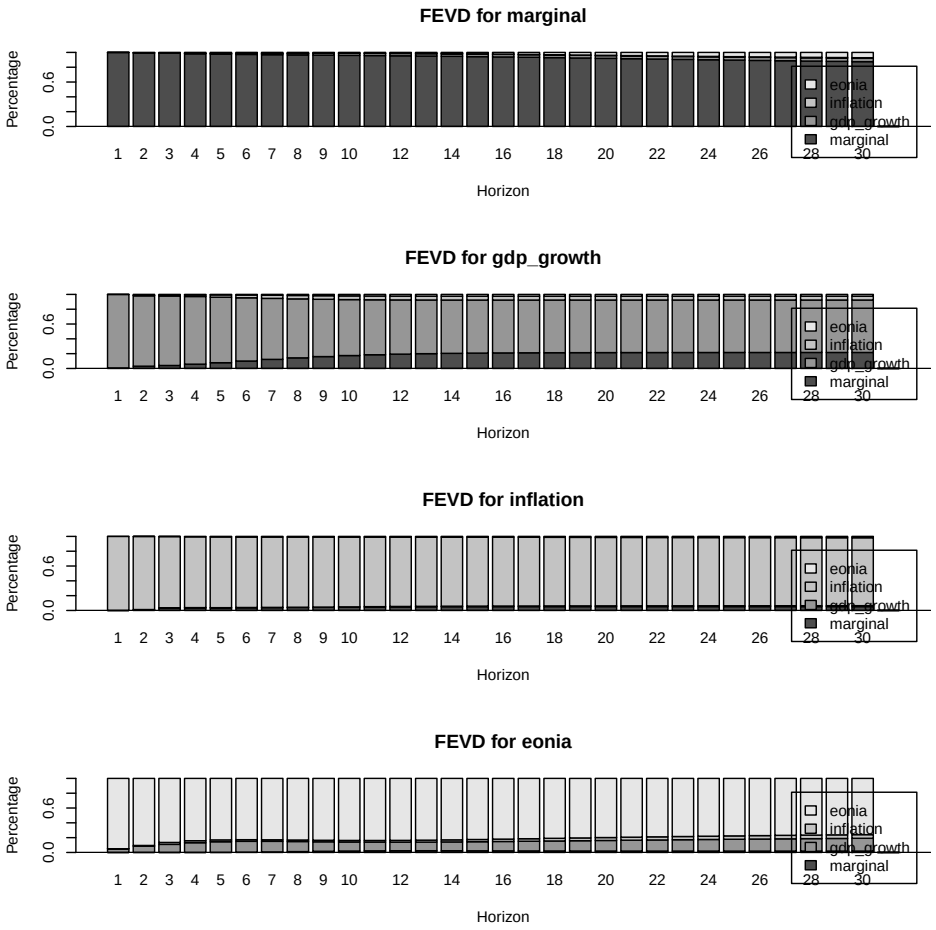


Figure 12: Historical Decomposition: Average marginal corporate tax - GDP growth

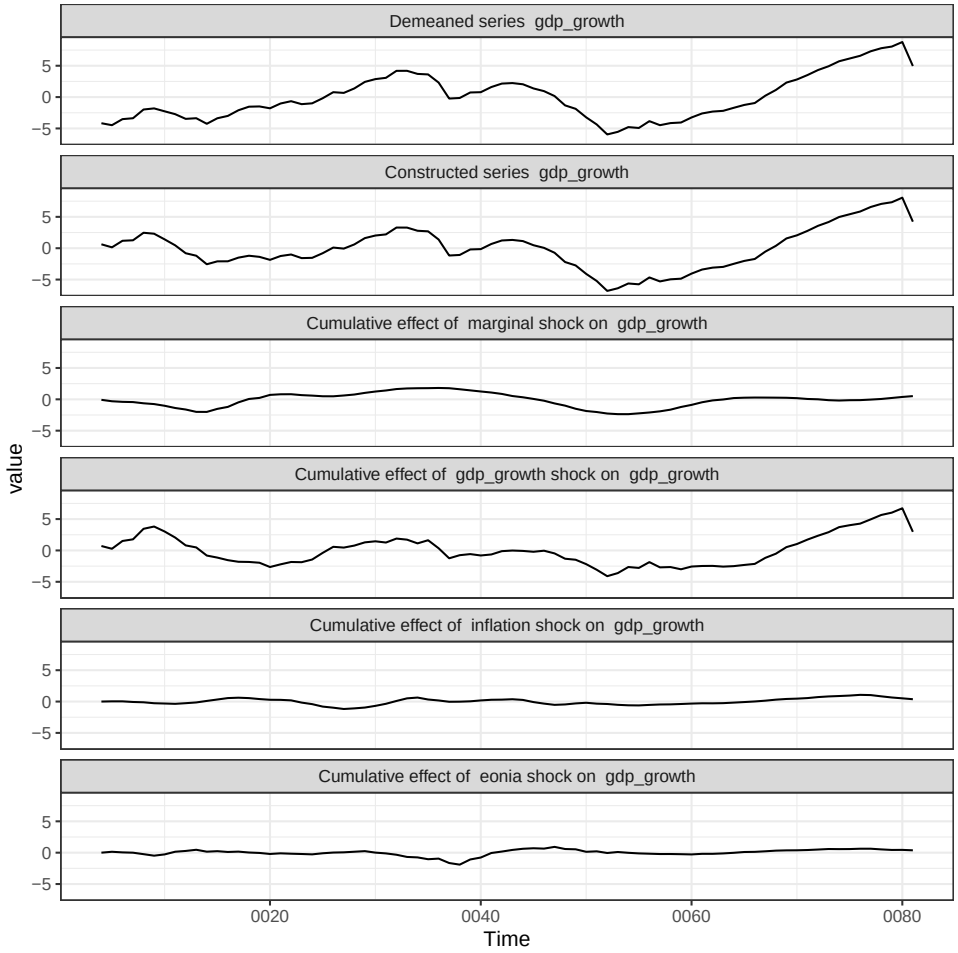


Figure 13: Most exogenous variable: Average marginal corporate tax

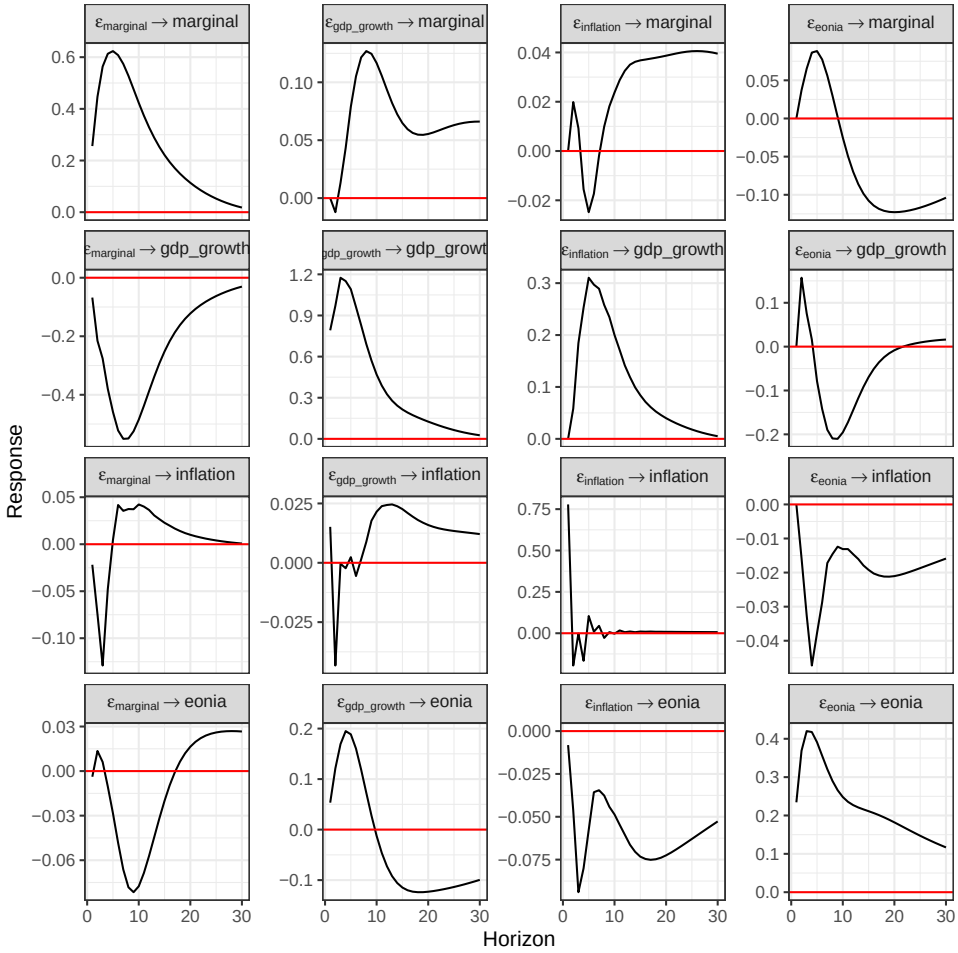


Figure 14: Most exogenous variable: GDP growth

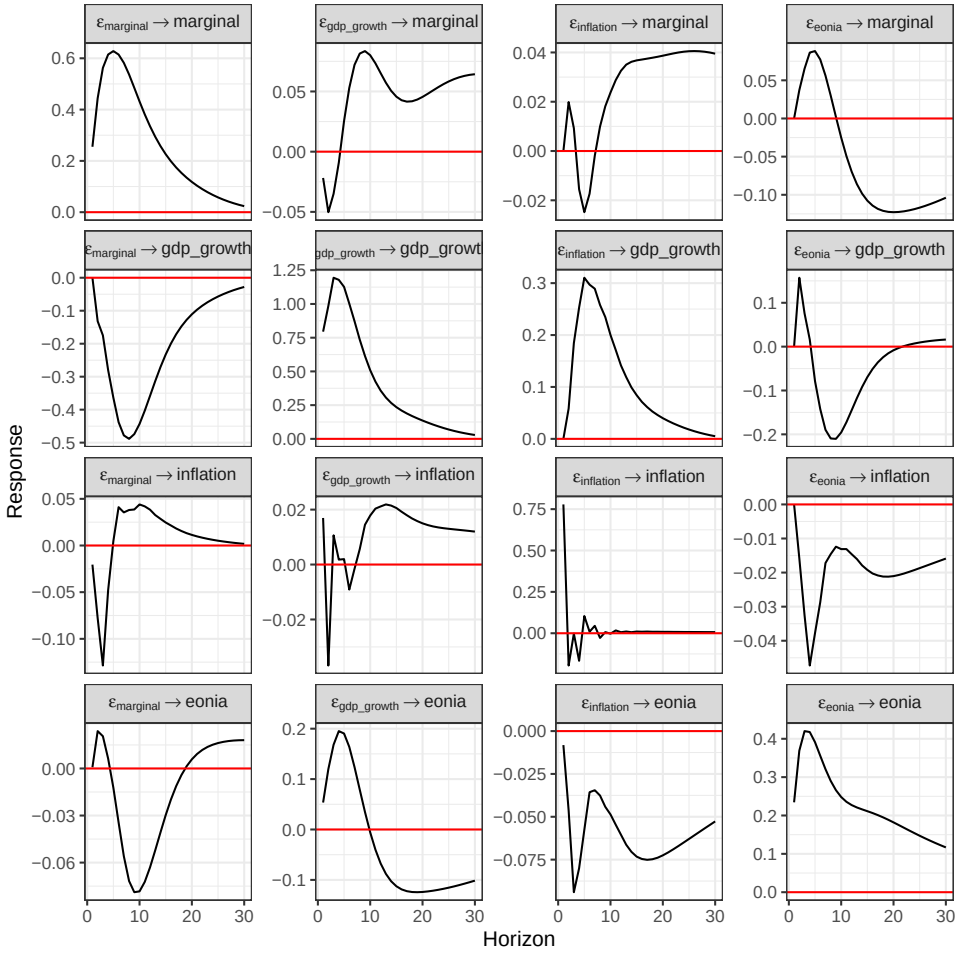


Figure 15: Most exogenous variable: Inflation

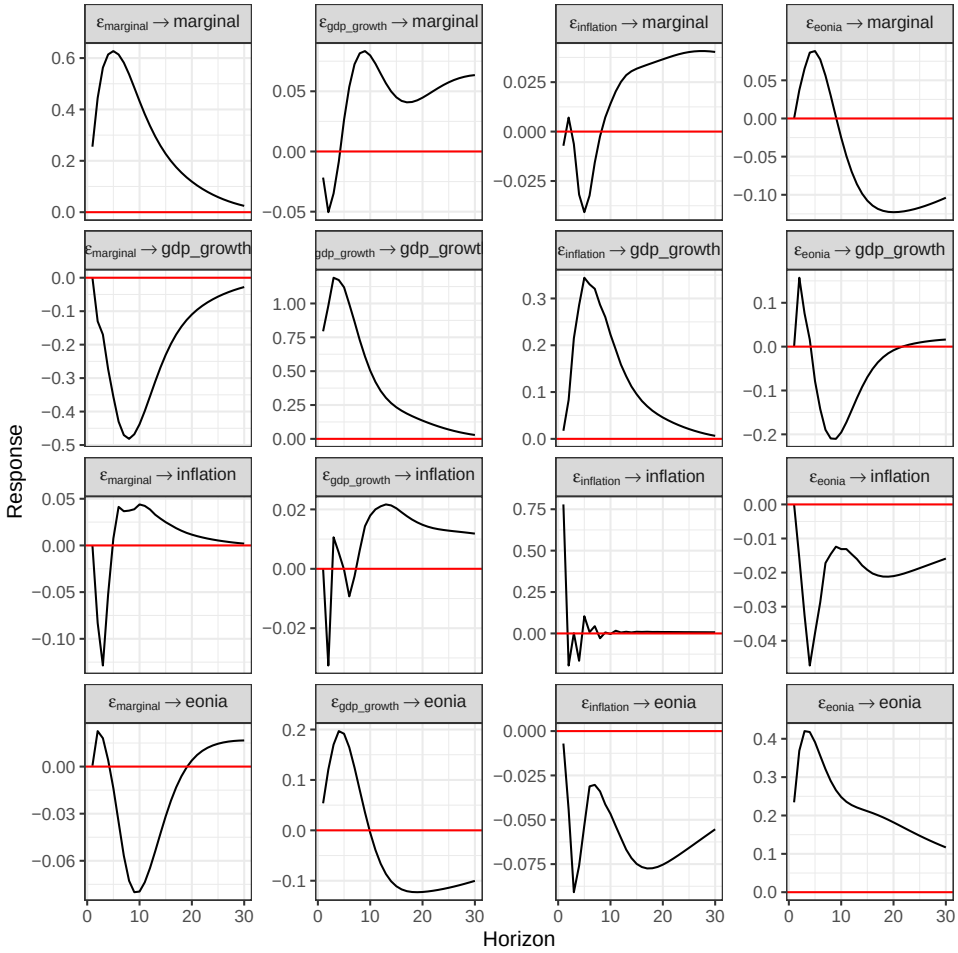


Figure 16: Most exogenous variable: Eonia interest rate

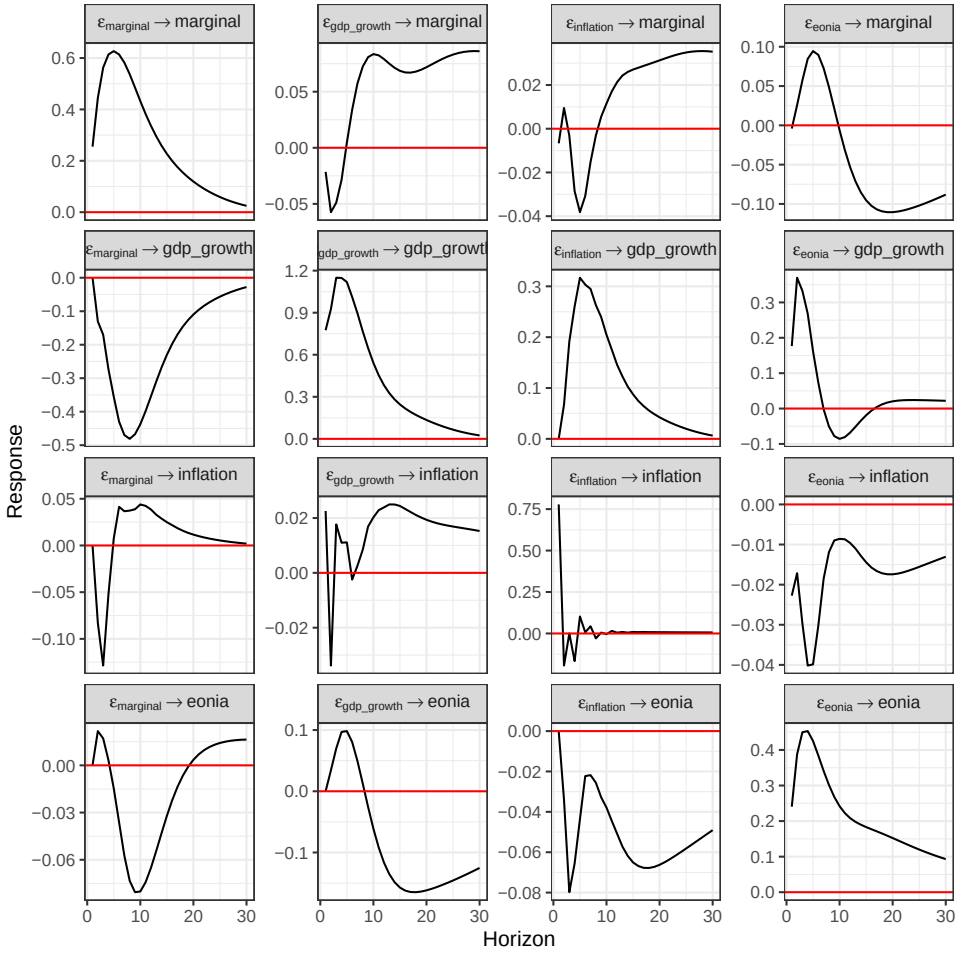


Figure 17: Augmented Dickey Fuller test: Var Residuals 3rd bracket marginal corporate tax

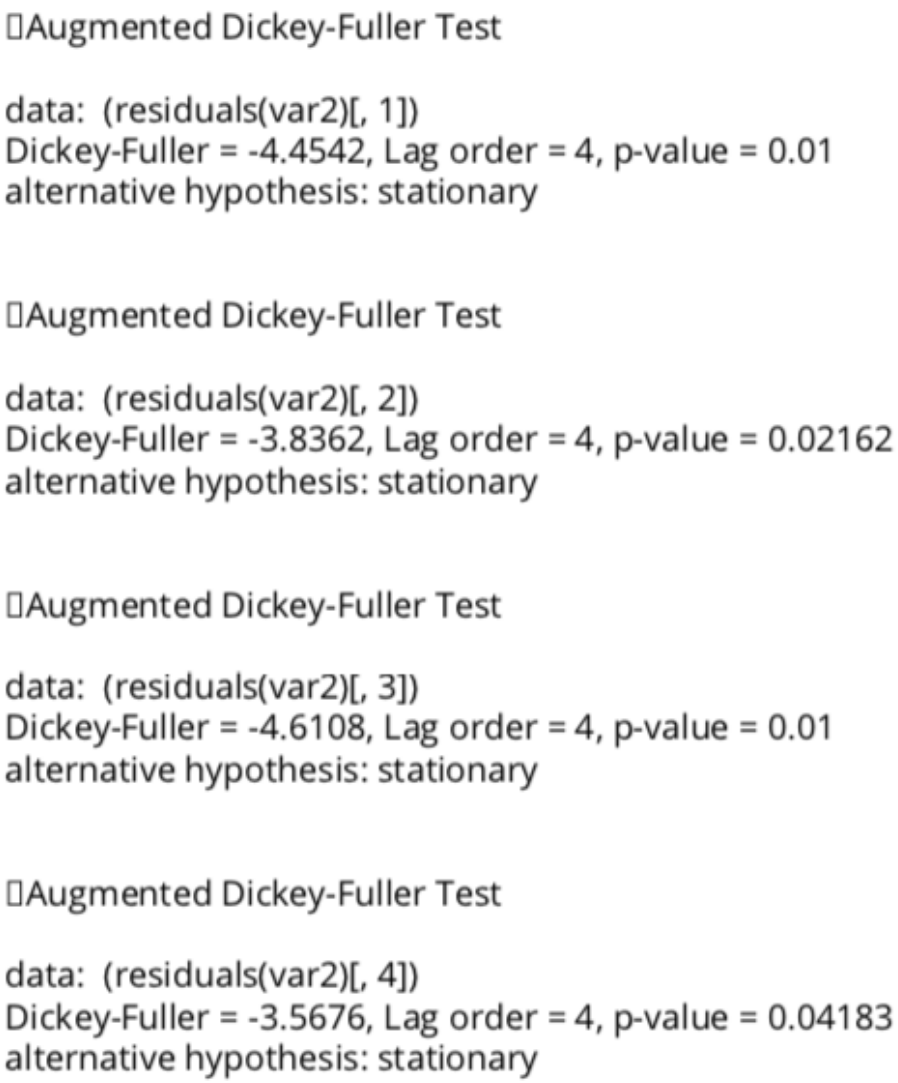


Figure 18: PACF: Var residuals 3rd bracket marginal corporate tax

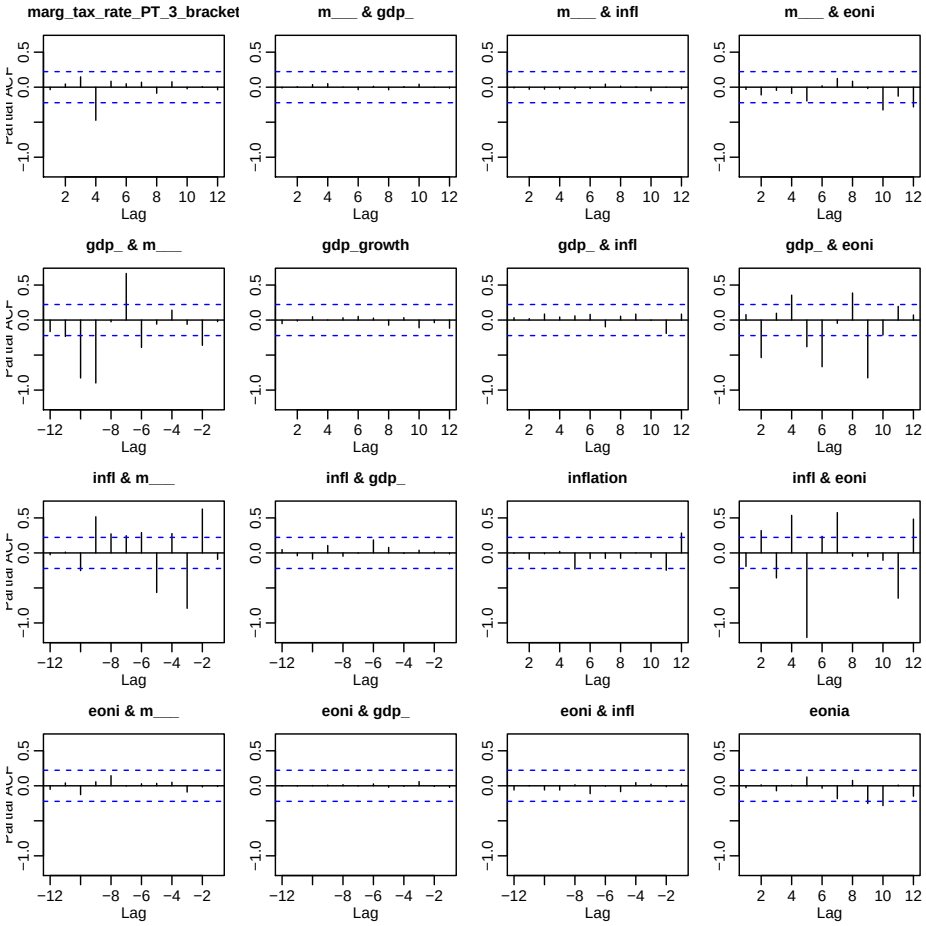


Figure 19: Variance Decomposition: 3rd bracket marginal corporate tax

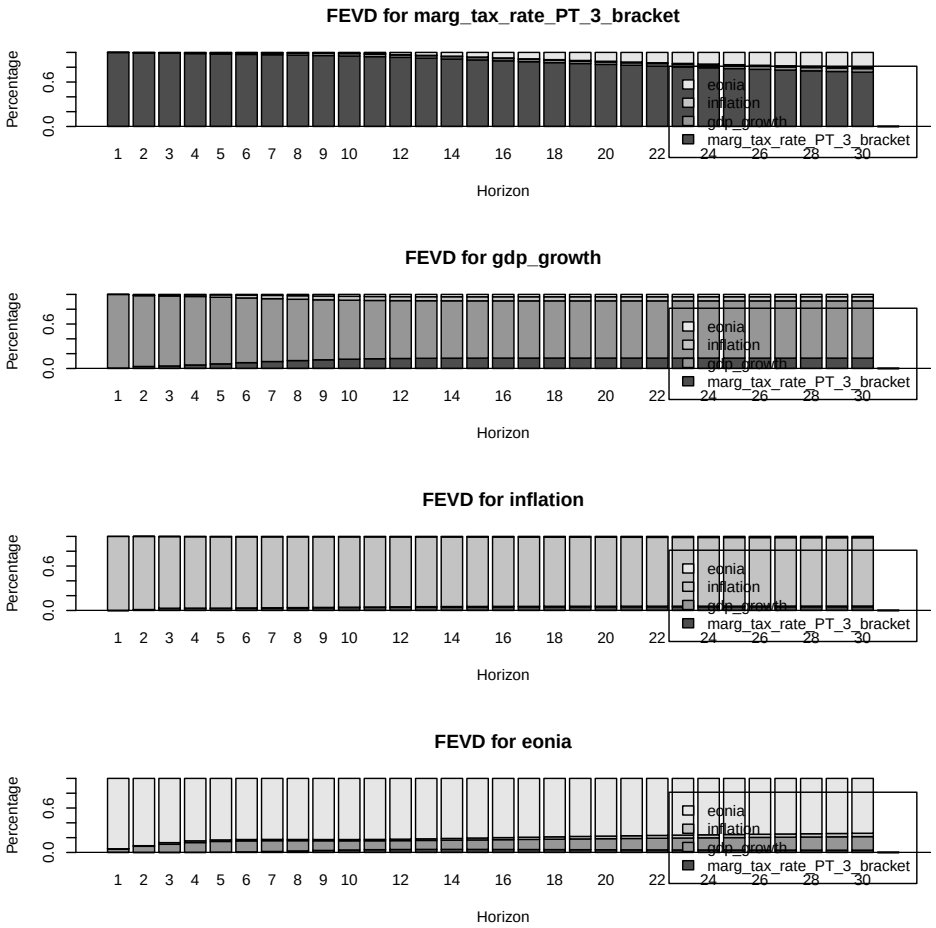


Figure 20: Most exogenous variable: 3rd bracket marginal corporate tax

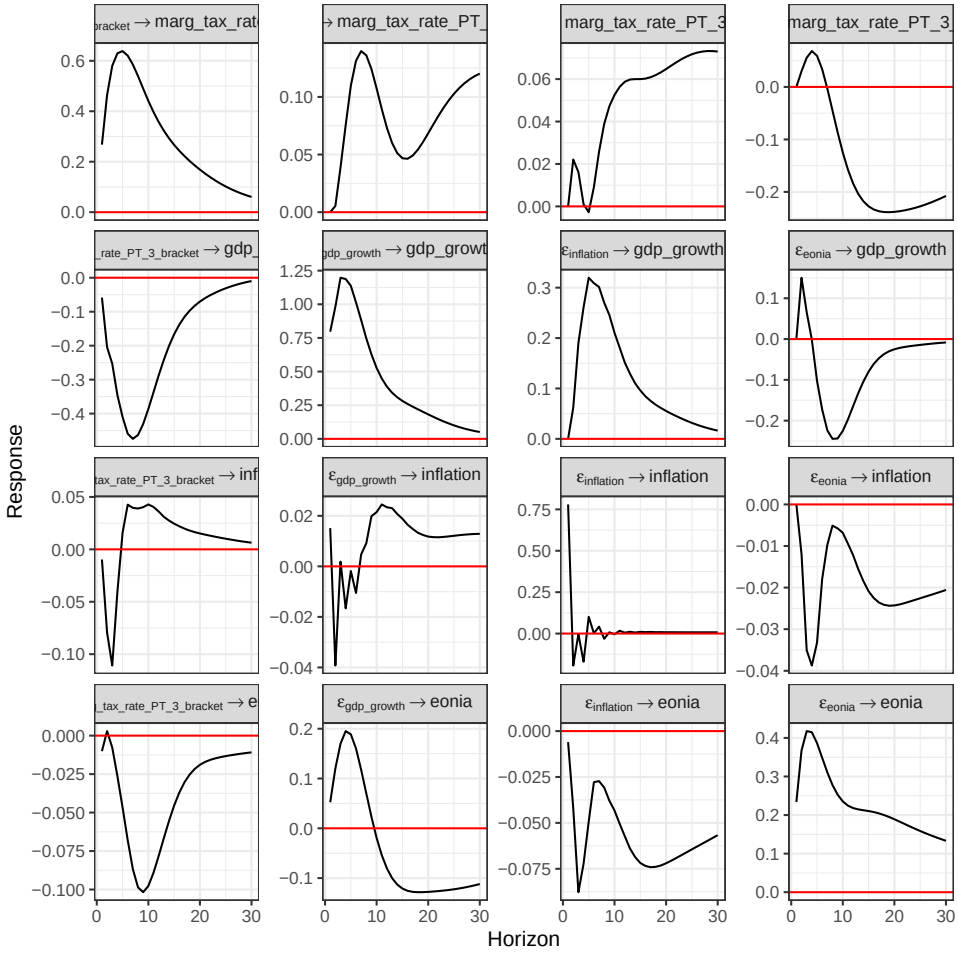


Figure 21: Most exogenous variable: GDP growth

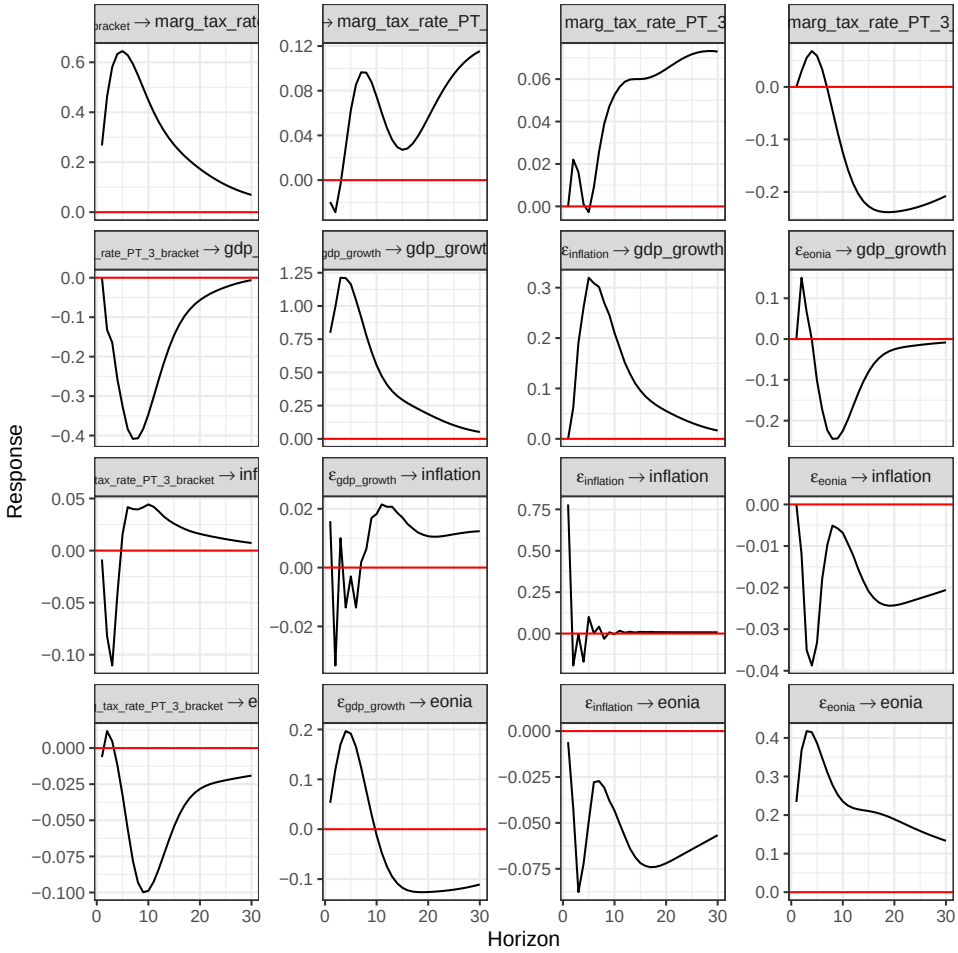


Figure 22: Most exogenous variable: Inflation

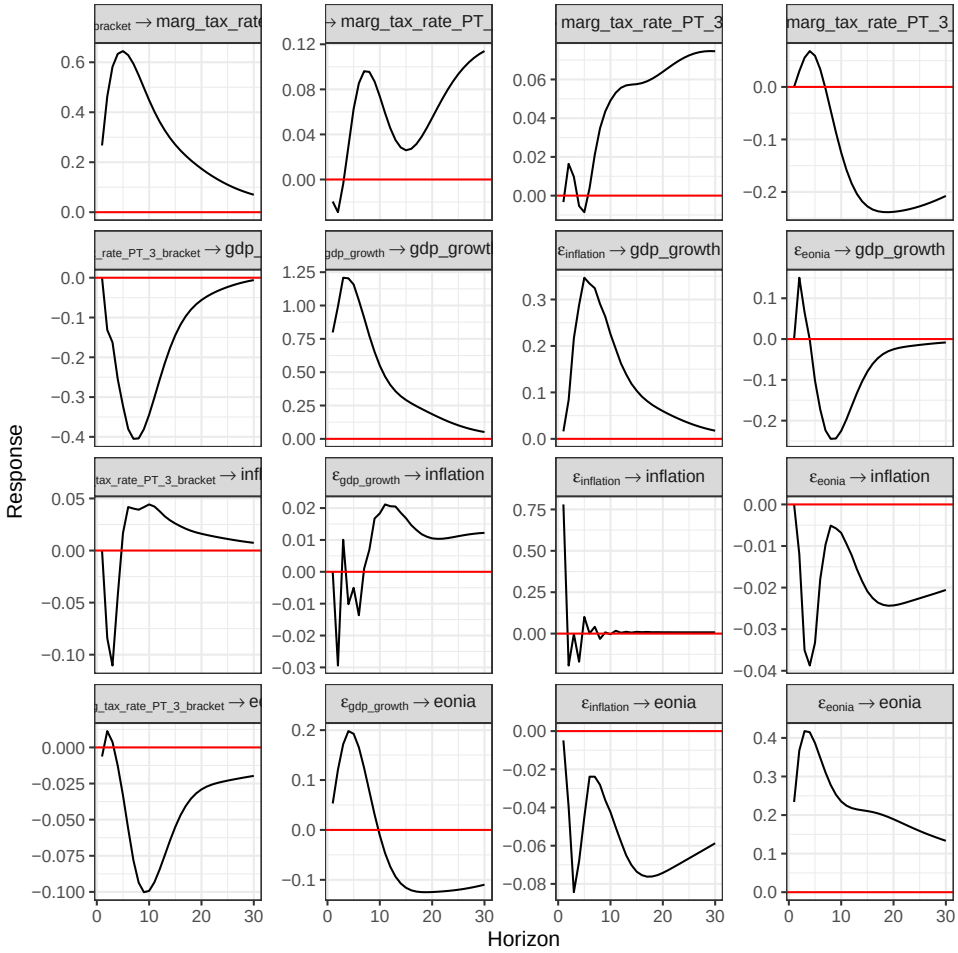


Figure 23: Most exogenous variable: Eonia interest rate

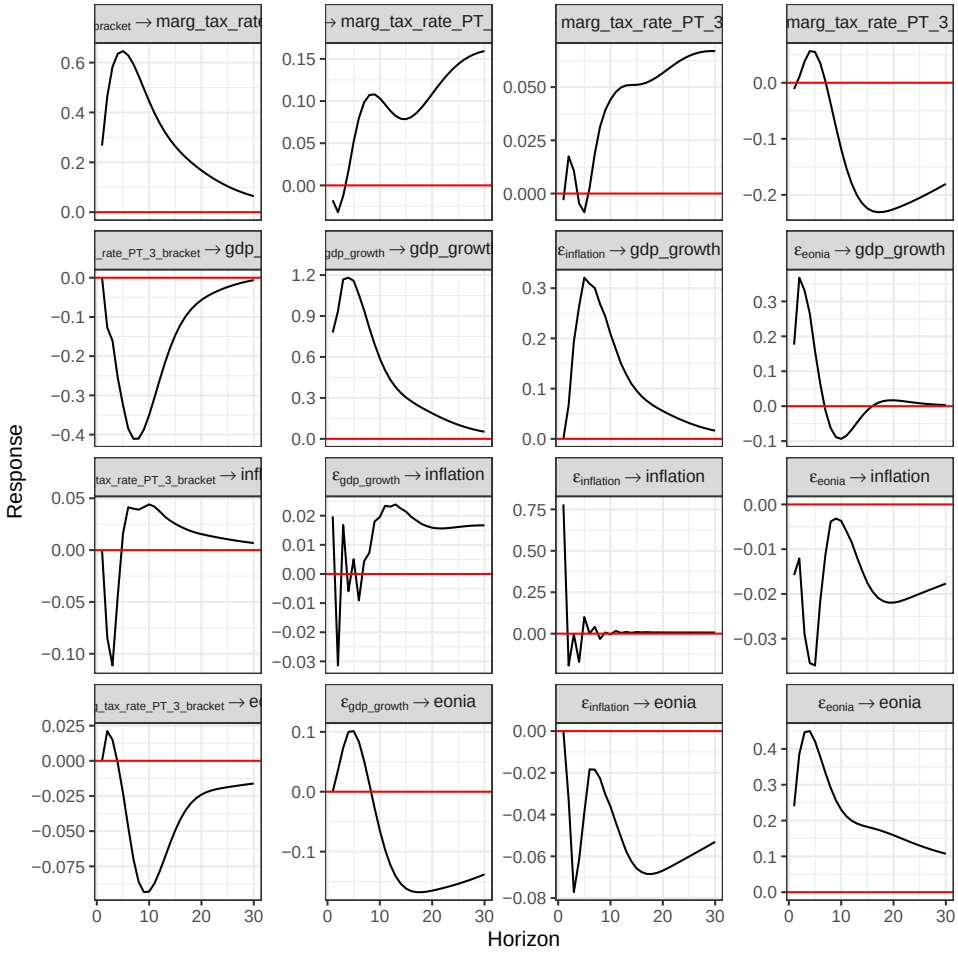


Figure 24: Augmented Dickey Fuller test: Var Residuals effective corporate tax

```
        Augmented Dickey-Fuller Test

data:  (residuals(var_tax)[, 1])
Dickey-Fuller = -5.0689, Lag order = 3, p-value = 0.01
alternative hypothesis: stationary


        Augmented Dickey-Fuller Test

data:  (residuals(var_tax)[, 2])
Dickey-Fuller = -4.6871, Lag order = 3, p-value = 0.01
alternative hypothesis: stationary


        Augmented Dickey-Fuller Test

data:  (residuals(var_tax)[, 3])
Dickey-Fuller = -4.7456, Lag order = 3, p-value = 0.01
alternative hypothesis: stationary


        Augmented Dickey-Fuller Test

data:  (residuals(var_tax)[, 4])
Dickey-Fuller = -4.6054, Lag order = 3, p-value = 0.01
alternative hypothesis: stationary
```

Figure 25: PACF: Var residuals effective corporate tax

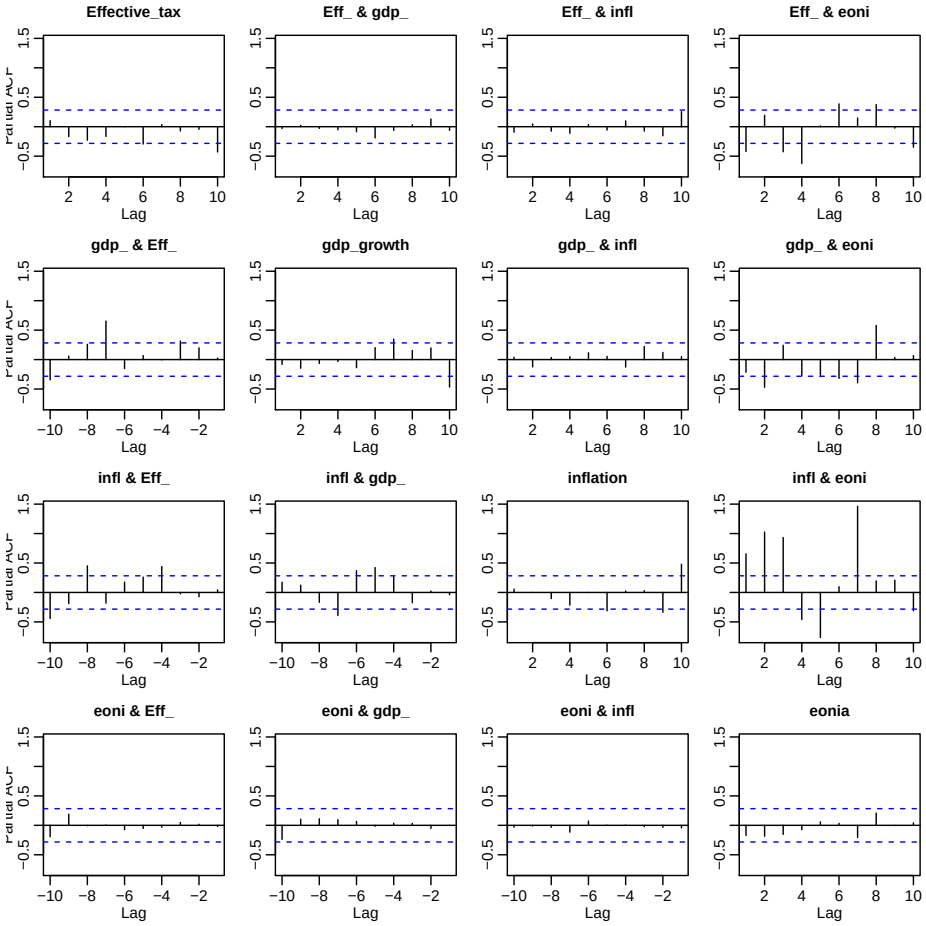


Figure 26: Variance Decomposition: Effective corporate tax

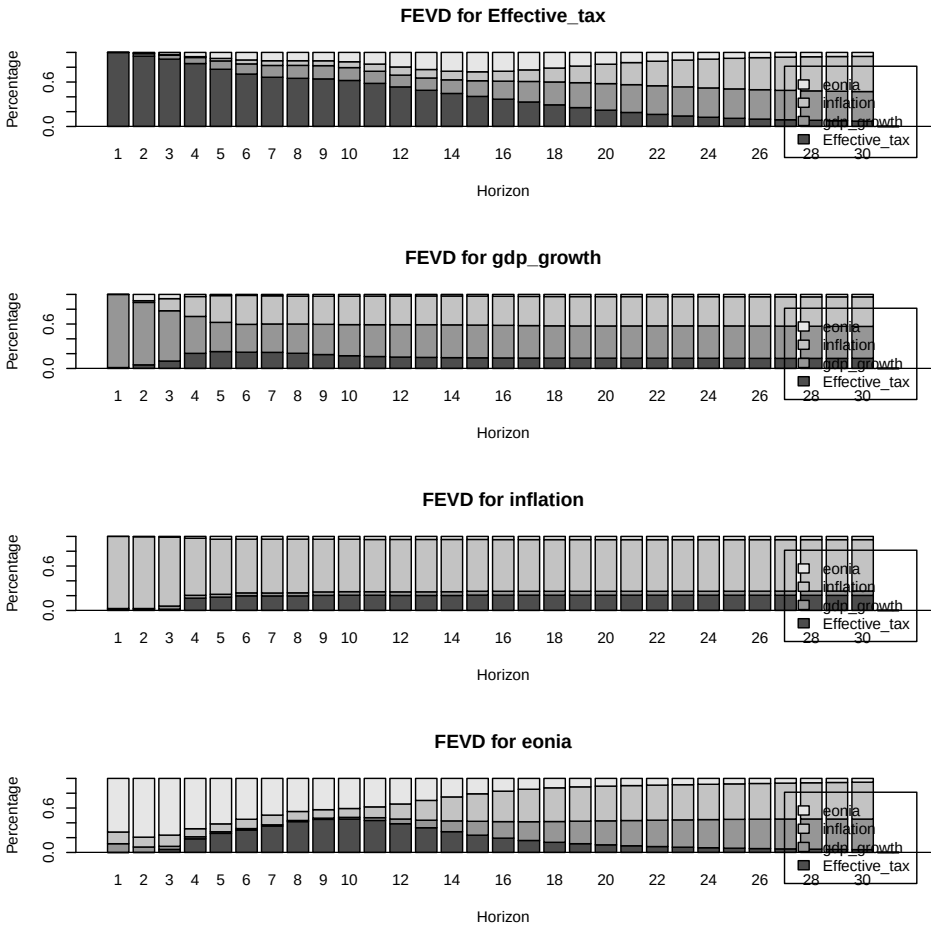


Figure 27: Most exogenous variable: Effective corporate tax

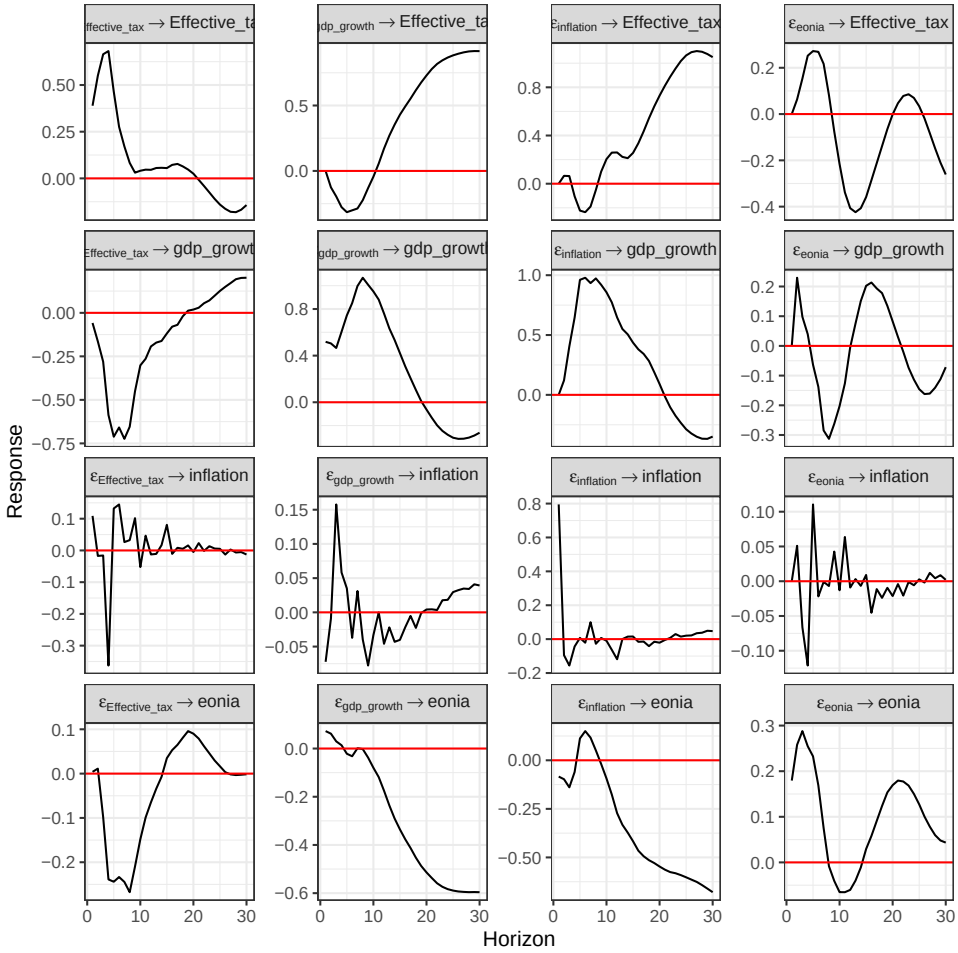


Figure 28: Most exogenous variable: GDP growth

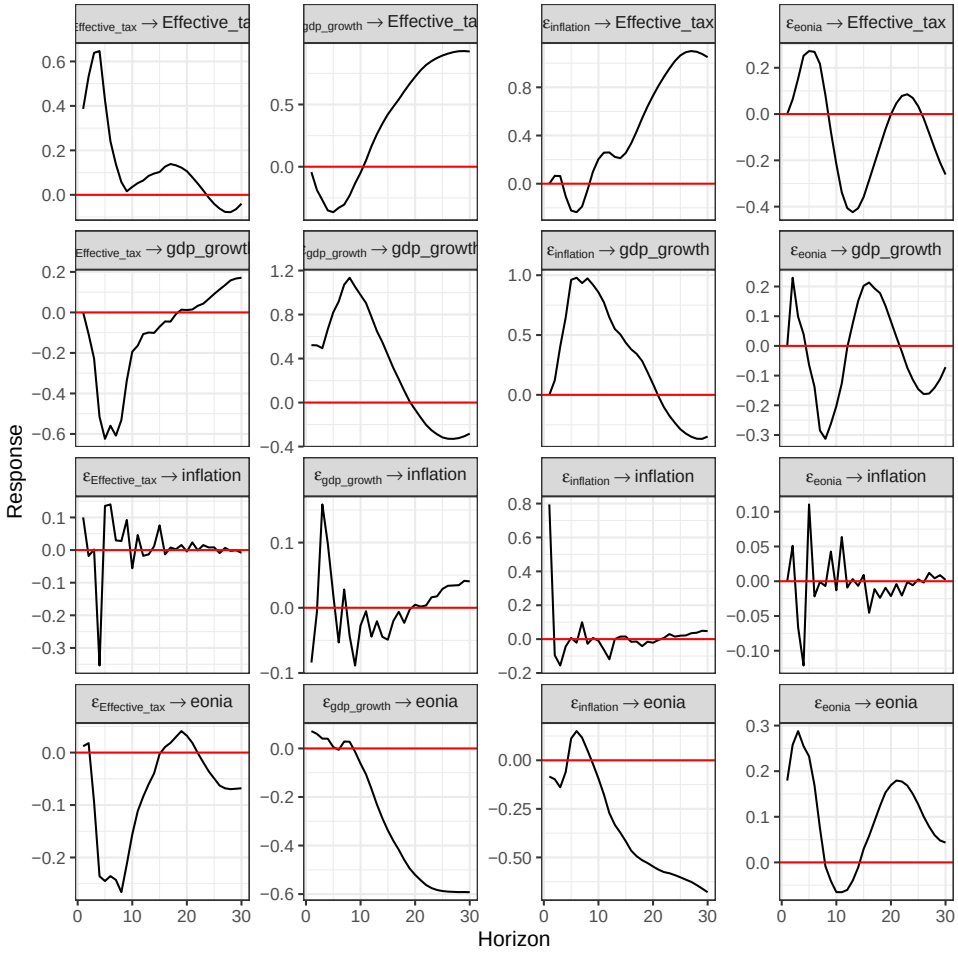


Figure 29: Most exogenous variable: Inflation

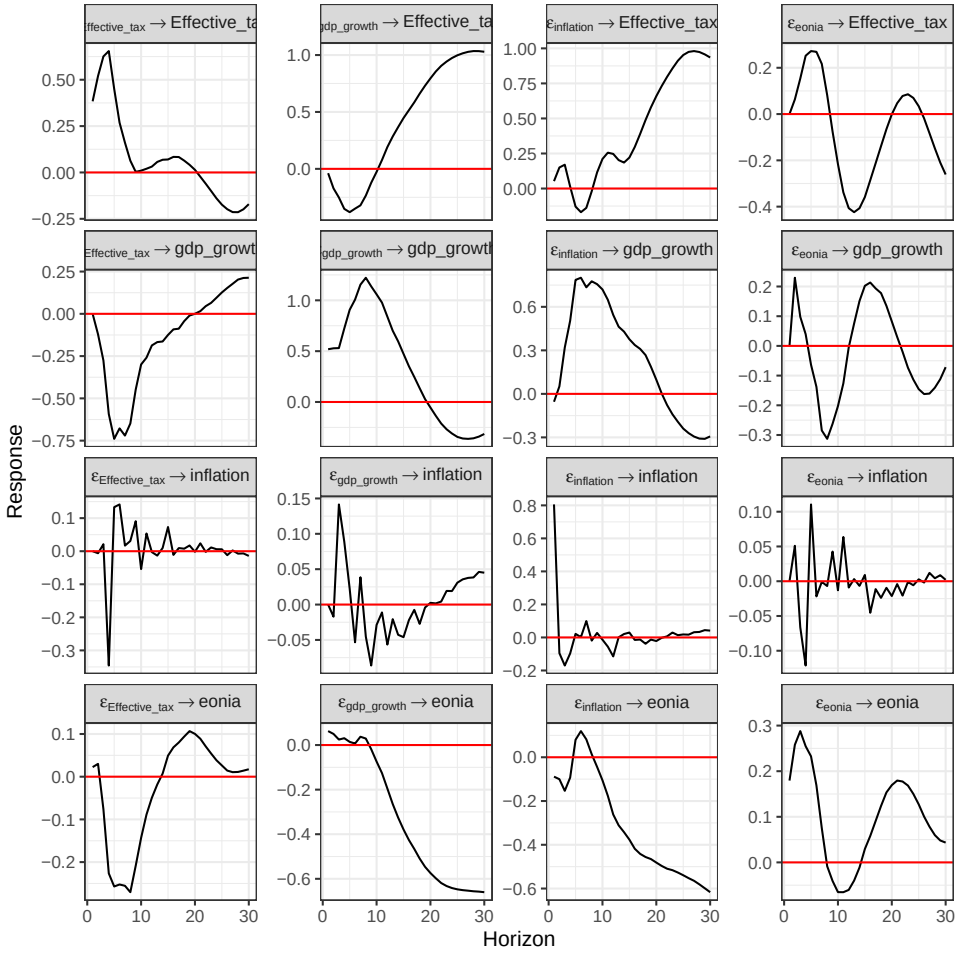


Figure 30: Most exogenous variable: Eonia interest rate

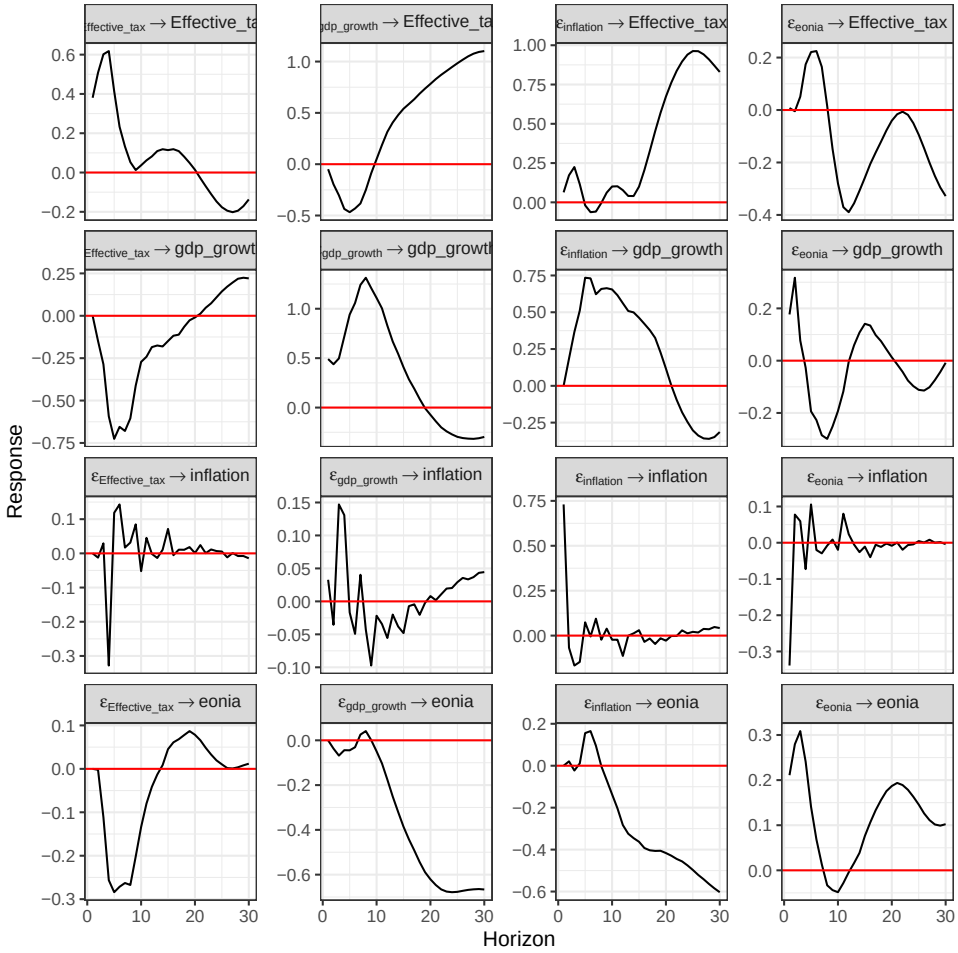


Figure 31: PACF: Var residuals unemployment

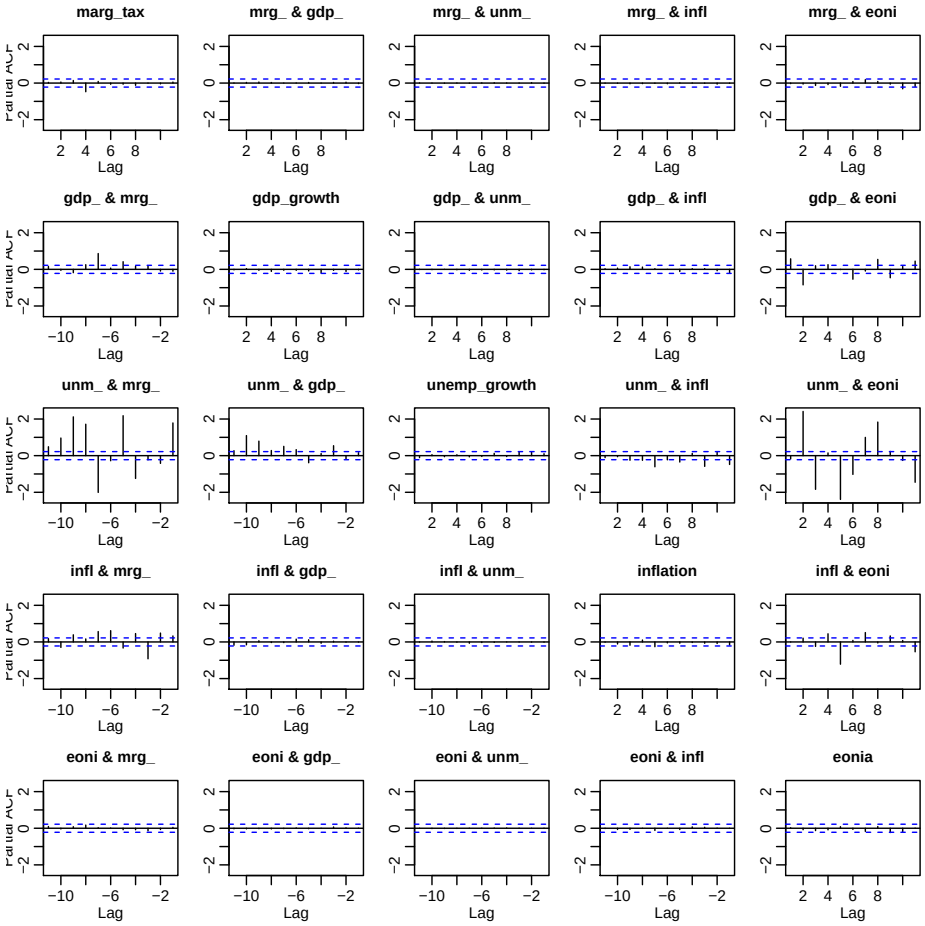


Figure 32: Augmented Dickey Fuller test: unemployment

```
 Augmented Dickey-Fuller Test

data:  (residuals(var_u)[, 1])
Dickey-Fuller = -4.3517, Lag order = 4, p-value = 0.01
alternative hypothesis: stationary


 Augmented Dickey-Fuller Test

data:  (residuals(var_u)[, 2])
Dickey-Fuller = -4.0008, Lag order = 4, p-value = 0.01401
alternative hypothesis: stationary


 Augmented Dickey-Fuller Test

data:  (residuals(var_u)[, 3])
Dickey-Fuller = -4.3071, Lag order = 4, p-value = 0.01
alternative hypothesis: stationary


 Augmented Dickey-Fuller Test

data:  (residuals(var_u)[, 4])
Dickey-Fuller = -5.1082, Lag order = 4, p-value = 0.01
alternative hypothesis: stationary
```

Figure 33: Variance Decomposition: Unemployment

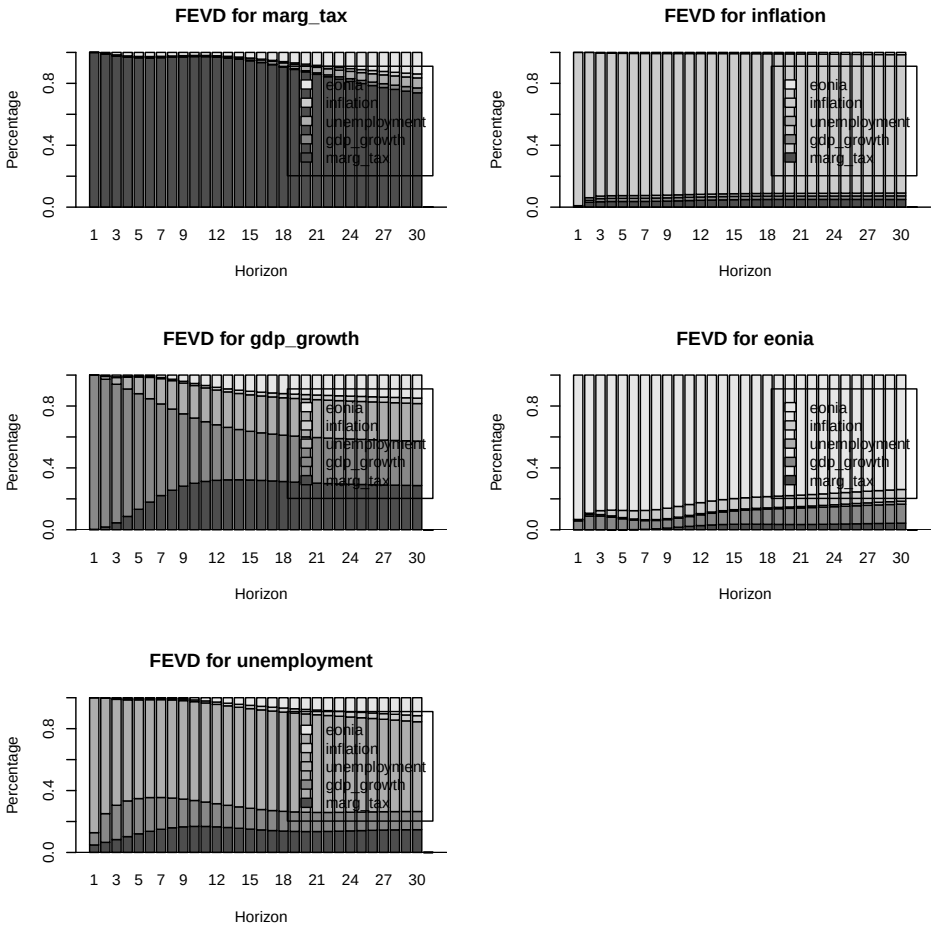


Figure 34: Most exogenous variable: Average marginal corporate tax

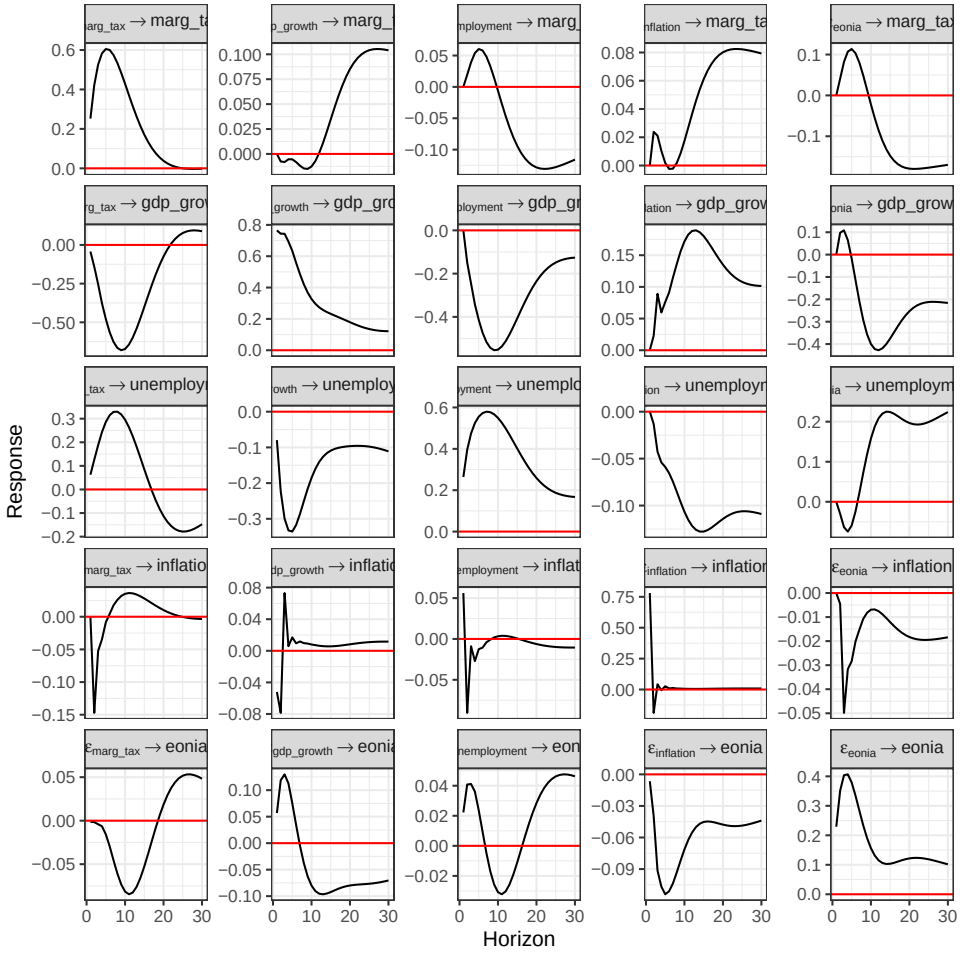


Figure 35: Most exogenous variable: GDP

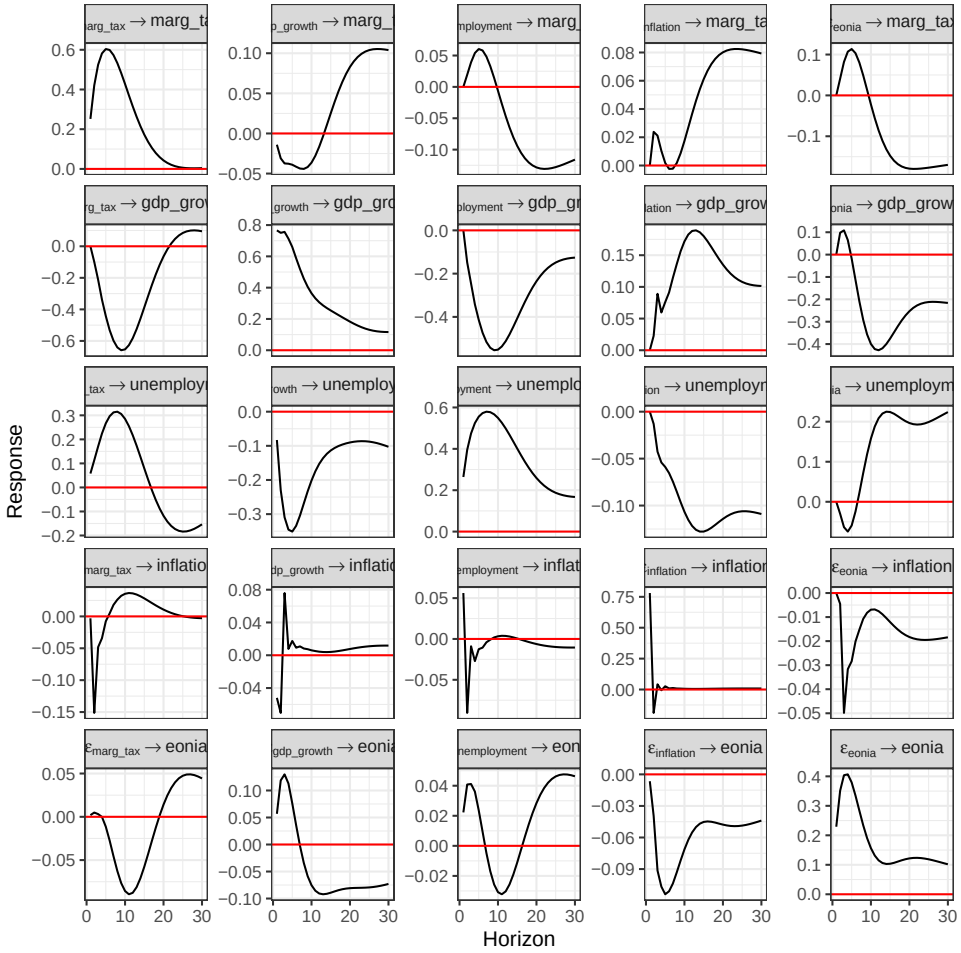


Figure 36: Most exogenous variable: Inflation

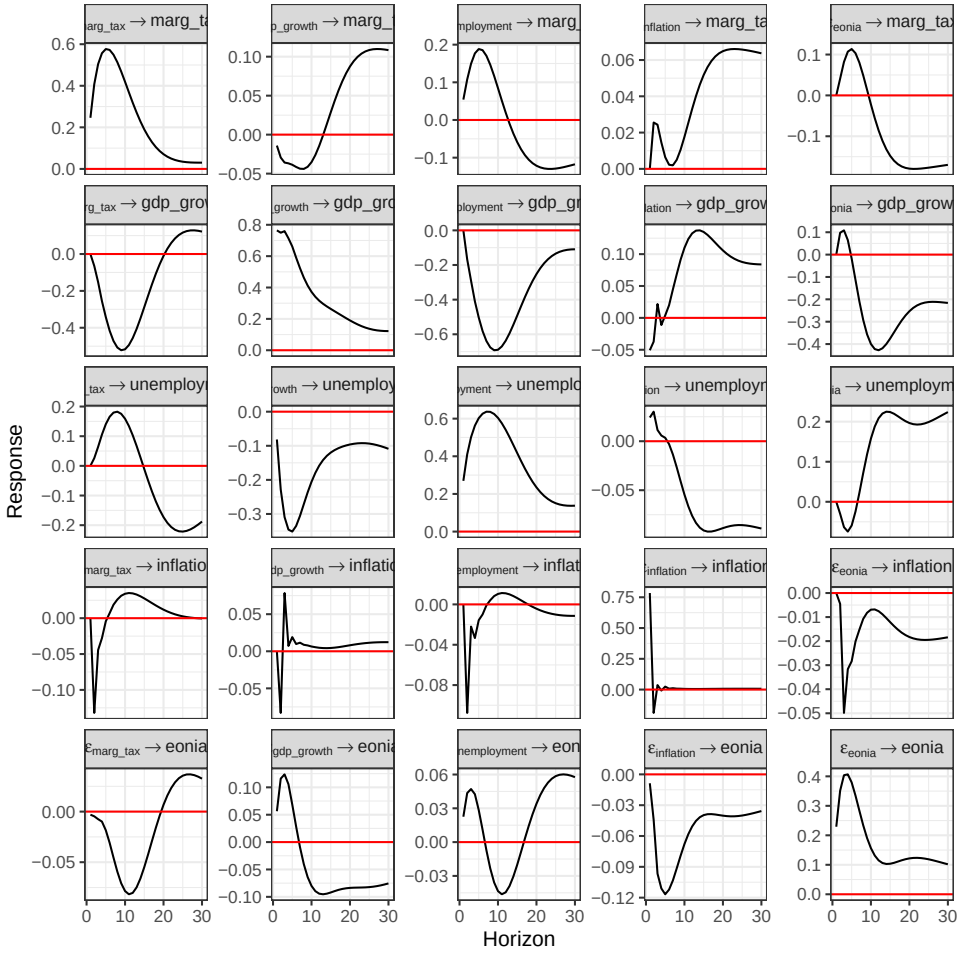


Figure 37: Most exogenous variable: Eonia interest rate